GROUNDWATER QUALITY REPORT FOR WATERTOWN CHARTER TOWNSHIP SPECIAL PROJECT

2023

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Project Description

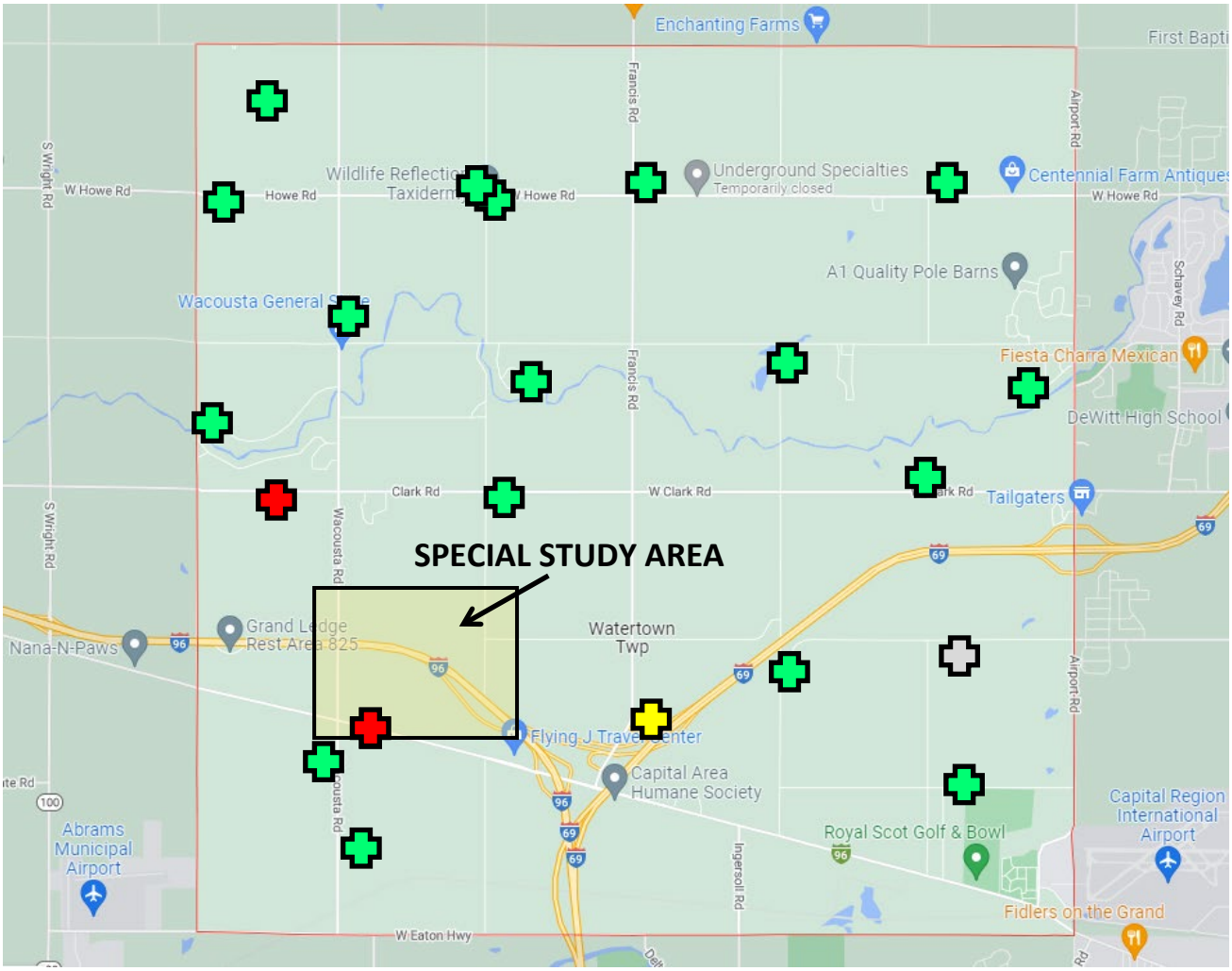
The major aquifer systems in Watertown Township, Clinton County Michigan, are made up of the Saginaw, Grand River, and Red Beds bedrock formations. A majority of people in Watertown Township obtain their water from wells which are completed in the Pennsylvanian-age Saginaw bedrock groundwater aquifer. Stratigraphically, the Saginaw is the oldest formation and overlain by the Grand River formation, and then the Red Beds. The Saginaw and Grand River formations form a continuous aquifer unit in the Township. The Jurassic age Red Beds formations, which consist of primarily clay, shale, and gypsum, acts as a confining layer. The Red Beds layer is not continuous across the Township but covers a large area.

In 2022 a groundwater survey was completed in Watertown Charter Township to help establish a baseline of water quality information for the area. Delta Township was also sampled in 2022, along with Windsor Township in 2023. Both DeWitt and Bath Townships were sampled in 2021. All of Ingham County was sampled from 2015 to 2020. The information collected from these surveys should be useful for water quality information and groundwater management.

The 2022 groundwater survey in Watertown Township indicated several wells with average groundwater chemistry results. One well did have an above average chloride level that was probably caused by road salt or water softener waste water discharge. One well did have an above average level for boron. Two wells had levels of arsenic at or above the EPA drinking water standard for arsenic, which is currently 10.0 ppb. Of the two wells, one had a result of 10.0 ppb. The other well had a level of arsenic at 22.0 ppb, which is significantly higher than other wells in the Township area. To further determine the extent of this level of arsenic in the groundwater, and to also ascertain groundwater chemistry in this area of the Township, a special project was conducted to sample several other wells in this smaller area.

This smaller area of the Township is characterized by having an active landfill site operated by the Granger Waste Services, and a major set of roads which includes Interstate I-96, West Grand River Highway and Wacousta road. The location of this special study area can be seen on Fig. 1, a map showing well locations from the 2022 survey.

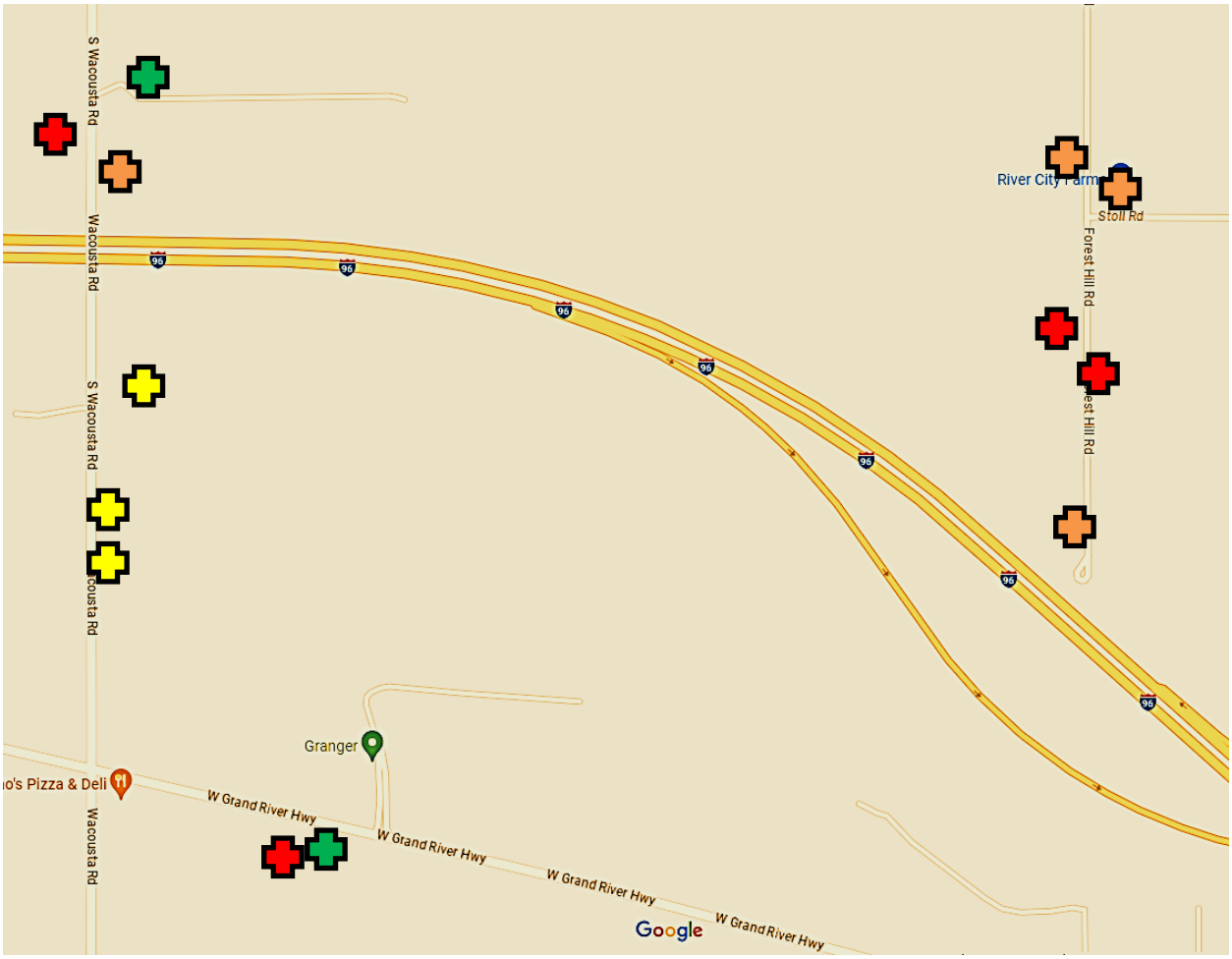
Figure 1 WATERTOWN CHARTER TOWNSHIP WELL SAMPLING SITES



Several letters were sent out from the Township to homeowners in the special study area. A total of 11 homes and one business were willing to participate in the water well sampling. Each water well owner was sent a copy of their water test results along with some educational material on the test results. The educational material was important to

share with homeowners to help them better understand how their water well system works. It was determined from past surveys that homeowners lack a basic understanding about water well systems and how to properly maintain them.

Figure 2 WELL TESTING SITES IN SPECIAL STUDY AREA



N

SCALE
1/4 MILE

AVERAGE WATER CHEMISTRY

ABOVE AVERAGE CHLORIDE LEVELS

ARSENIC LEVELS AT OR ABOVE EPA DRINKING WATER STANDARD OF 10 PPB

ARSENIC LEVELS AT OR ABOVE EPA DRINKING WATER STANDARD OF 10 PPB AND CHLORIDE ABOVE AVERAGE LEVELS

Results of the Special Survey

A total of 12 wells were sampled for this study. Coliform Bacteria presence was tested and found in one of the wells. E. Coli bacteria was not present in any of the wells. Various water chemistry parameters were tested to access the groundwater quality. Average mean values of the *primary parameters* tested were calculated.

Table 1: Mean values of the *primary* water chemistry data with a comparison of the first Watertown Township survey data to the Special Area survey data. All mean values are shown in parts per million (ppm) except pH and conductivity, which is shown in units of micro-Siemens per centimeter. A red *P Value* indicates a statistical significant difference between the mean values.

PARAMETER	*WATERTOWN (mean)*	*SPECIAL AREA (mean*	*MANN-WHITNEY Z*	*P VALUE*
ALKALINITY	**359.7**	**392.5**	**-2.65711**	**.00782**
ARSENIC	**0.003**	**0.013**	**-3.96695**	**.00008**
BORON	**0.185**	**0.022**	**2.84423**	**.00452**
CALCIUM	**81.2**	**111.0**	**-3.87339**	**.0001**
CHLORIDE	**7.27**	**33.50**	**-2.84423**	**.00452**
CONDUCTIVITY	**638**	**765**	**-2.78809**	**.00528**
HARDNESS	**326.9**	**437.1**	**-4.0418**	**<.00001**
IRON	**1.34**	**2.63**	**-2.69453**	**.00714**
MAGNESIUM	**30.1**	**38.8**	**-3.63013**	**.00028**
NITRATE	**<0.40**	**<0.40**	**-**	**-**
pH	**7.35**	**7.28**	**1.45954**	**.1443**
POTASSIUM	**2.0**	**1.6**	**1.60923**	**.1074**
SODIUM	**8.9**	**11.2**	**-0.50522**	**.61006**
SULFATE	**18.5**	**43.3**	**-2.43256**	**.0151**
FLUORIDE	**0.40**	**0.27**	**2.00219**	**.0455**
SILICA	**14.5**	**20.3**	**-3.79854**	**.00014**

For these major parameter results that were non-detectable, the value inputted to calculate the average was estimated to be one third of the reporting limit for all reported non-detectable levels for a given parameter. This was done because parameter results

reported as non-detectable don't guarantee the parameter is completely absent from the sample. In the study, nitrate was non-detectable in all well samples and therefore the mean was less than the reporting limit of 0.40 ppm.

Significant differences were seen with most of the major parameters between the first Watertown Township survey and the special area survey. The exceptions were pH, potassium and sodium. Of particular importance was the difference in chloride and arsenic levels between the two surveys with the special area having higher levels for both.

Average temperature for the wells tested in the special area was 11.4 degrees Celsius or 52.5 degrees Fahrenheit. An average flow rate from all the wells was 10.3 gallons per minute. Test results were non-detectable for all wells tested for chromium, copper, mercury, nitrate, nitrite, and selenium. Lead was detected in 3 wells at 0.005 ppm, 0.002 ppm, and 0.006 ppm, or 5, 2, and 6 ppb. These levels are below the EPA action level for lead of 0.015 ppm or 15 ppb. Homeowners with these detectable lead levels were provided information on reducing lead levels in their drinking water.

Figure 3 Chart showing special survey well locations based on chloride/bromide ratios. Chart was prepared by Michigan Department of Environment, Great Lakes and Energy, (EGLE), Lansing District, EGLE Drinking Water GIS database.

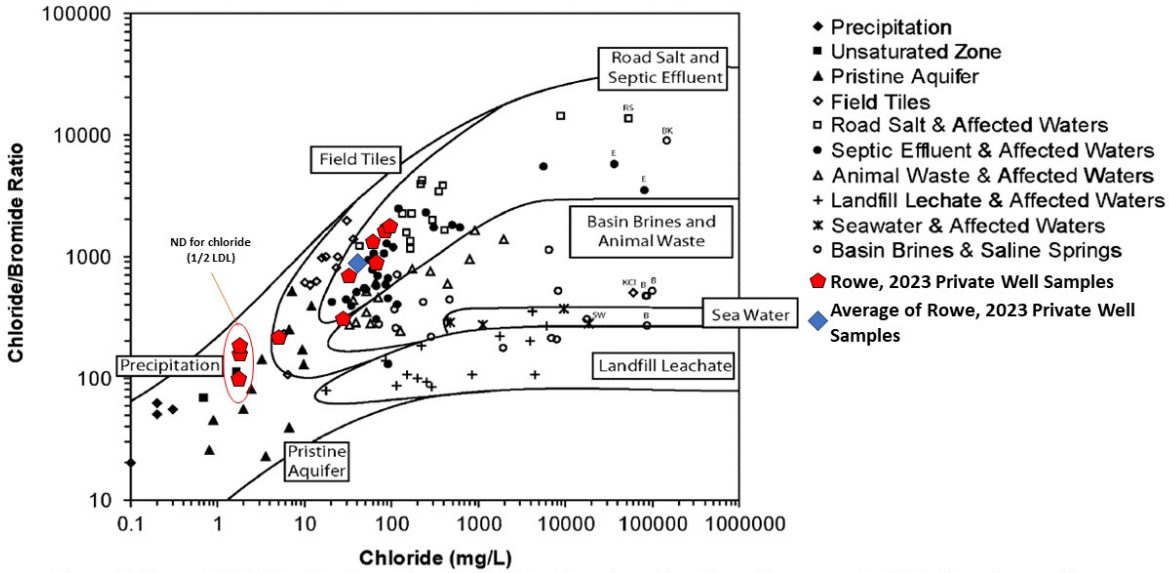


Figure 3. Rowe, 2023 Chloride:Bromide vs Chloride, plotted on chart from Panno et al., 2006. Non-detects for Chloride are plotted at 2 mg/L Chloride (1/2 the laboratory detection limit of 4 mg/L)

Of the 12 wells sampled, 10 wells were tested for bromide. The range seen was 0.011 – 0.096 ppm, or 11 – 96 ppb. The average value was 0.047 ppm or 47 ppb. Bromide was used to help determine the source of chloride in the wells using a Cl/Br ratio, (Rowe,

Garry, 1986, Davis, S.D., Whittemore, D.O, and Fabryka-Martin, J., 1998, Panno, S.V., Hackley, K.C., Hwang, H.H., Greenberg, S.E., Krapac, I.G., Landsberger, S., and O'Kelly, D.J., 2006). Ratio numbers were calculated as 3653, 1664, 4414, 1244, 209, 266, 709, 2011, 470, 128. For wells with chloride levels of 28.0 ppm or higher, this suggests road salting as the possible main source of chloride, (see Figure 3).

Outside the primary parameters analyzed, other water chemistry parameters were tested to ensure safe drinking water based on the National Primary Drinking Water Regulations, (United States Environmental Protection Agency (EPA), 2021).

Table 2: Comparison of 2022 survey data with parameters regulated by the EPA as part of the National Primary Drinking Water Regulations. All values are in parts per million (ppm).

Parameter	National Primary Drinking Water Regulations	2022 Mean
Arsenic	0.010	0.013
Barium	2.00	0.18
Cadmium	0.005	<0.0003
Chromium	0.10	<0.01
Copper	*TT action level =1.30	<0.05
Fluoride	4.00	0.27
Lead	*TT action level =0.015	0.002
Mercury	0.002	<0.0001
Nitrate	10.00	<0.40
Selenium	0.050	<0.001
Nitrite	1.00	<0.05

Lead and Copper are monitored through Treatment Techniques (TT) set by the Lead and Copper Rule (LCR). LCR requires action if more than 10% of customers taps

sampled exceed the action level, (United States Environmental Protection Agency (EPA), 2021).

The parameters manganese, zinc and total dissolved solids were also tested. Results for these parameters were within levels usually found in the Township. Lithium was also tested for in this survey. Recent work on lithium in drinking water has raised some concerns for Public Health and a possible drinking water standard for lithium may be forthcoming, (USGS, 2021), (Zeyan Liew, et.al., 2023). The range found for lithium was <0.010 ppm to 0.012 ppm, or <10 to 12 ppb. The average level was <0.01 or <10.0 ppb. Public water supplies may soon be required to monitor and test for lithium in their water systems.

Arsenic Levels

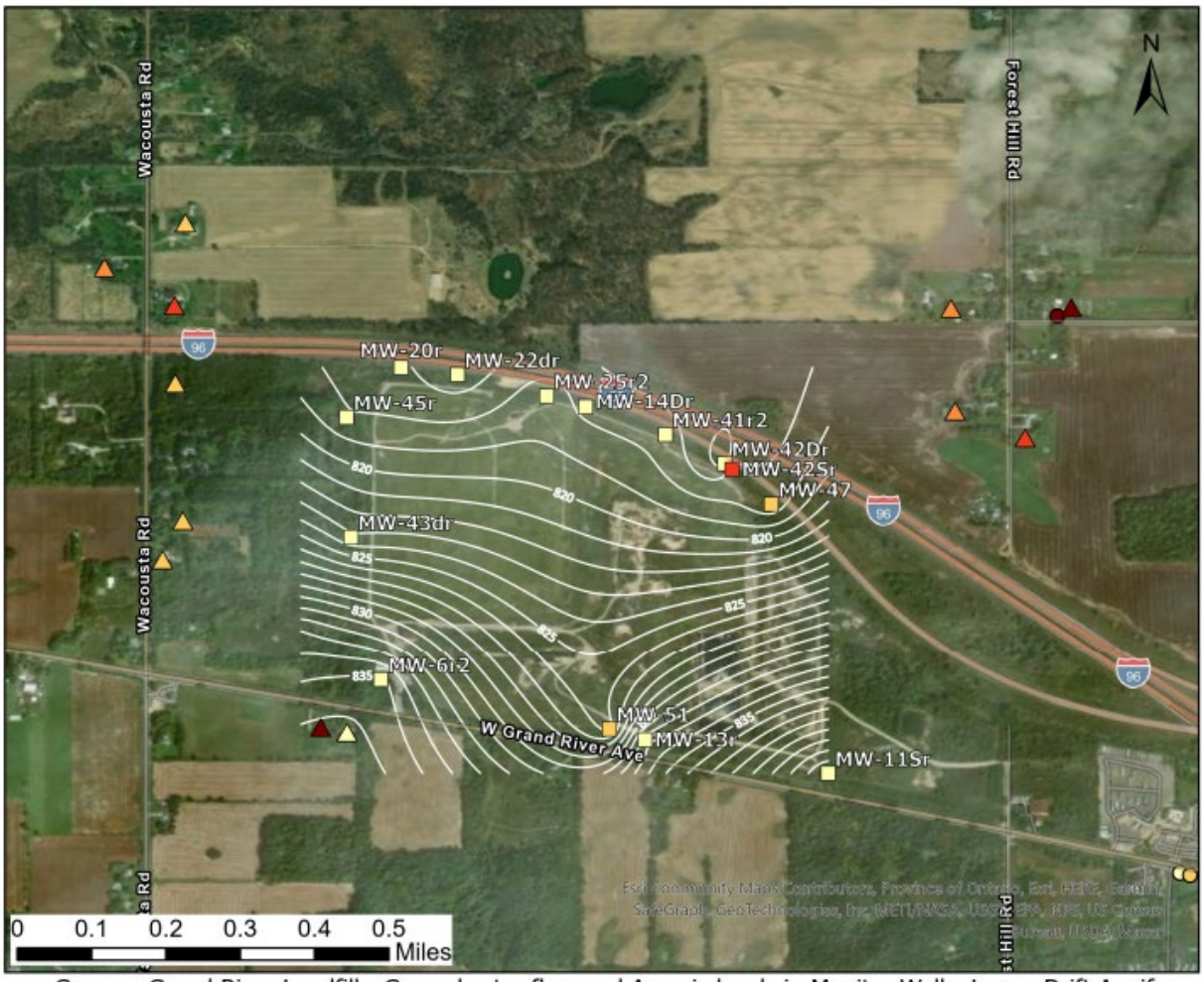
Levels of arsenic in the special study area were significantly higher than those seen in the rest of Watertown Township, (Table 1). To answer the question of why the levels of arsenic are so much higher in this area, several sources were considered.

The first concern was the Granger landfill located in the center of this area. Information provided from the EGLE Drinking Water GIS database, (EGLE, 2023), indicated that monitoring wells in the shallow glacial drift did not demonstrate levels of arsenic as high as those seen in the tested private wells, with the exception of one well, (MW-42Sr, 0.015-0.020 ppm). Direction of groundwater flow is to the north, see Figure 4.

Figure 5 shows direction of groundwater flow in the bedrock aquifer to be to the northeast. There are only 3 monitoring wells shown for the deeper bedrock aquifer. Two wells on the north side of the landfill, (MW-17B, MW-18B), indicated low arsenic levels, (not detected to 0.005 ppm). The third bedrock monitoring well, (MW-16rB), did indicate a level of arsenic close to what is seen in the private wells, (0.015-0.020 ppm). This well is located in the southeast section of the landfill site and is up-gradient to the landfill site. Monitoring well MW-16rB would reflect groundwater not affected by the landfill and does have a level of arsenic close to a private well south of the landfill on Grand River Highway, which would also be up-gradient from the landfill.

Other information from EAGLE also indicates that arsenic levels seen in the special study area have been seen in other locations in the Tri-County areas of Ingham, Clinton and Eaton counties, but are not common. Most wells sampled in this area usually have levels of arsenic below the EPA drinking water standard of 0.010 ppm or 10.0 ppb. These higher levels of 0.011 to 0.026 appear to be unique for this special study area. This information is provided in Figure 6.

Figure 4



Granger Grand River Landfill - Groundwater flow and Arsenic levels in Monitor Wells, Lower Drift Aquifer (January, 2023 sampling) and Private wells (June 2023 sampling)

Legend

Monitor Wells - ALL

Arsenic (ppm)

- 0 - 0.005
- 0.005 - 0.01
- 0.01 - 0.015
- 0.015 - 0.020
- 0.020 - 0.025

Rowe_Samples (2023)

Arsenic (ppm)

- 0 - 0.005
- 0.005 - 0.010
- 0.010 - 0.015
- 0.015 - 0.020
- 0.020 - 0.025

Figure 5

Granger Grand River Landfill - Groundwater flow direction and Arsenic levels in Monitor Wells, Bedrock Aquifer (January, 2023 sampling) and Private wells (June 2023 sampling)

Legend

Bedrock Monitor Wells

Arsenic (ppm)

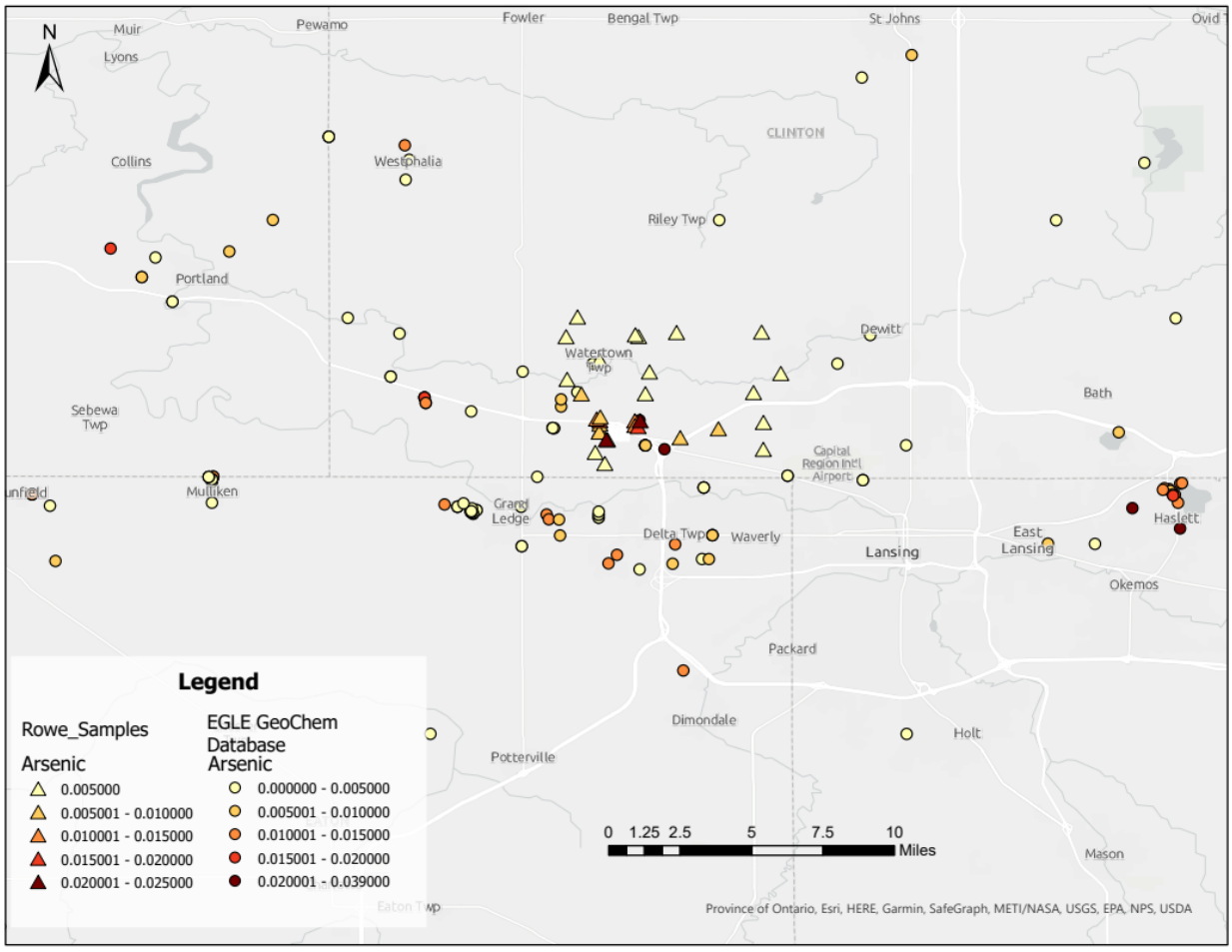
- 0.00 - 0.005000
- 0.005001 - 0.010000
- 0.010001 - 0.015000
- 0.015001 - 0.020000
- 0.020001 - 0.025000

Rowe_Samples (2023)

Arsenic (ppm)

- 0 - 0.005
- 0.005 - 0.010
- 0.010 - 0.015
- 0.015 - 0.020
- 0.020 - 0.025

Figure 6



Another possible source for the arsenic levels is road salting causing conditions near highways and major roads to increase mobilization of heavy metal levels into the environment, (Backstrom,et.al., 2003, Schuler, et.al., 2018). Road salting may change soil structure, soil chemistry, and the release of heavy metals such as lead, mercury, chromium, and arsenic. Figure 7 provided by EGLE, shows levels of arsenic in relation to location or proximity to the highway corridor (Grand River Rd./I-96/69). These diagrams suggest that the cause of the arsenic levels in this area could also be road salting. As indicated earlier it was determined from the chloride/bromide calculations that road salting could be the primary cause of the increased chloride levels in this area.

Figure 7 Charts showing the relation between arsenic levels in sampled wells and distance from the major roads (EGLE).

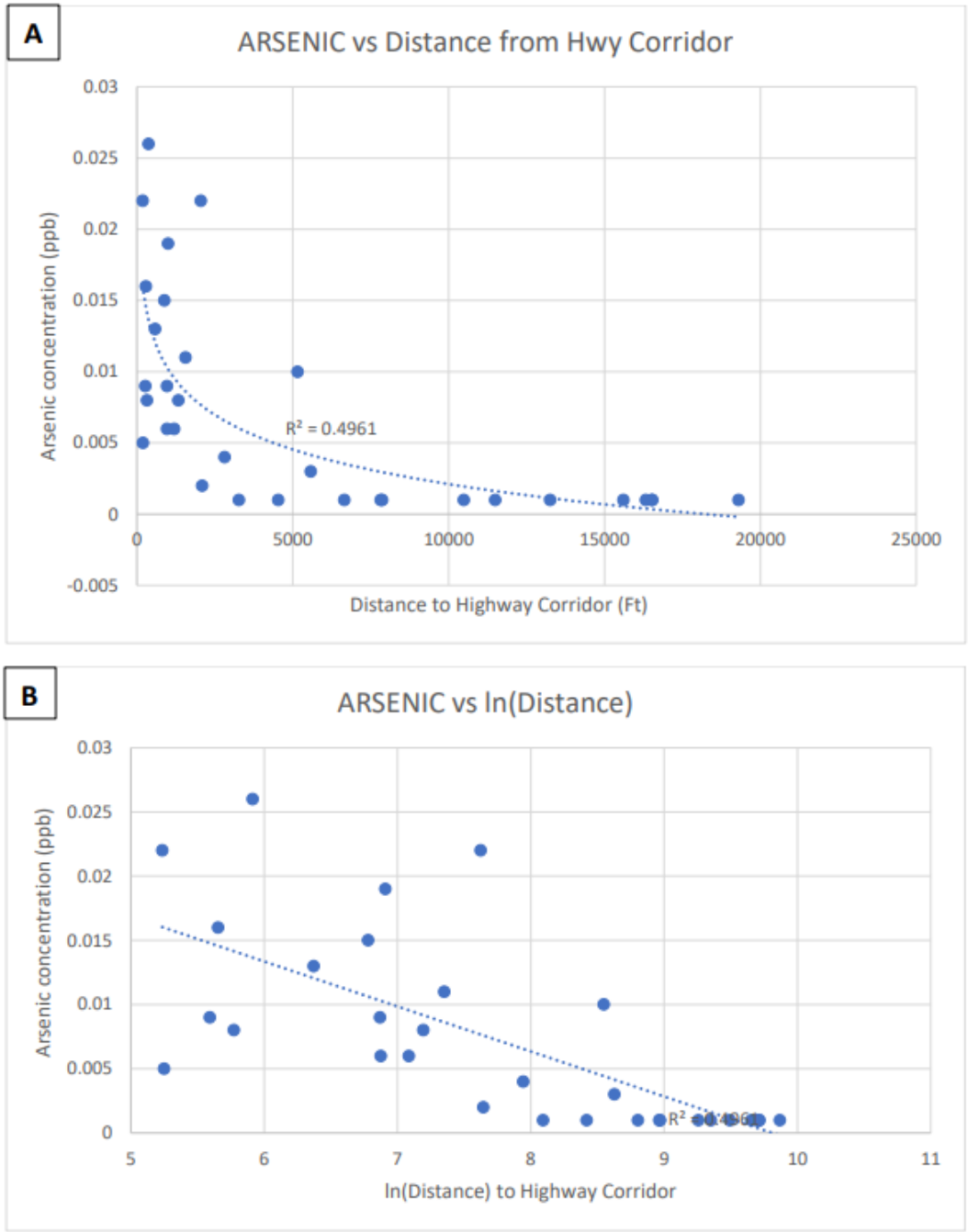


Figure 1 – A) Arsenic concentrations vs the linear distance to Highway corridor (Grand River/I-96/69), with logarithmic regression trendline. **B)** Arsenic concentrations vs the natural log of distance to Highway corridor (Grand River/I-96/69). Data from Rowe, 2023 residential well sampling.

The special study area has higher hardness, calcium, magnesium, sulfate and iron levels then the rest of Watertown Township, see Table 1. Eleven wells were also sampled for volatile organic compounds. Results were “Not- Detected” for all eleven wells. Michigan State University also collected samples for DNA sequencing of microbes, total organic carbon, and nitrogen in the groundwater, while also checking for oxidation - reduction conditions. The oxidation - reduction conditions in the groundwater were typical for bedrock wells. One well had an unusually high total organic carbon result compared to the other wells,(Shrenk, M., 2023). Other results were still pending at the writing of this report.

In Summary

Results of the water well testing in this special area of Watertown Township indicated chemistry that is very unique and different from the rest of the Township, Table 1. The water has much higher hardness with higher calcium, magnesium, iron, conductivity and sulfates. Chloride levels were also much higher and Cl/Br ratios still suggest road salting as the primary cause. As with other Township reports, water softener wastewater discharges from homes may also be contributing to the chloride levels.

Arsenic levels are a major concern. The source of the arsenic may be natural. As suggested by some recent research, road salting may also be causing local conditions to mobilize arsenic in the groundwater. The landfill site in this location was considered as a possible source, but the monitoring well data from the site, in addition to other well testing in this Michigan location seems to rule this out.

Recommendations

Homeowners and business facilities in this area should be advised about the groundwater chemistry in this area of the Township. Homeowners and business facilities need to be encouraged to have their private water wells tested for a routine bacteriological, partial chemical and arsenic test every 2 to 3 years. Sample kits are available at the Michigan Drinking Water laboratory, which can be reached at 517-335-8184. Wells in this area should also be sampled every 5 years for a more complete water chemistry testing, such as the one in this study. To help with the reduction of chloride in this area, facilities and homes need to inspect the discharge of water softener system wastewater to reduce the impact to the environment. Some water treatment systems can be purchased that do not use salt. Further assistance and questions may be directed to the Mid-Michigan District Health Department office at 989-224-2195.

Acknowledgements

This special project acknowledges the important contributions of Watertown Charter Township. The township's financial and administrative assistance was critical to the success of the survey. In particular, Andrea Z. Polverento, Township Planning Director, was very helpful in finding suitable sampling sites which was very much appreciated.

Dr. Matthew Shrenk and his team of students were very helpful in the collection of water samples. His analysis for several parameters including oxidation-reduction conditions, total organic carbon, DNA sequencing of microbes, etc., will be helpful in better understanding the groundwater in this area.

Staff from EGLE were also very helpful in providing some of the groundwater mapping conditions. They also provided critical data information regarding arsenic levels for groundwater in this area.

Finally, this study would like to give a big "thank you" to all the homeowners who participated in the sampling of their water supply wells the project would not have been possible without their help.

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