GROUNDWATER QUALITY REPORT FOR BATH TOWNSHIP

1995/2021

Project Description

Majority of people in Clinton County Michigan obtain their water from wells which are completed in the Pennsylvanian-age Saginaw bedrock Aquifer. However, there are some wells which were completed in the Jurassic-age Red Bed Aquifers which consist of primarily clay, shale, and gypsum.

In 1995 a groundwater survey was conducted in Bath Township that assessed the groundwater quality. A total of 32 wells were sampled throughout the township to get a quality understanding of the groundwater. In addition, the wells were selected in a fashion to provide an adequate spread over the township. The purpose of this study was to establish a baseline of water chemistry to determine potential changes over time in the area.

The 1995 groundwater survey indicated a local concern such as a slightly high iron concentration as well as moderately high hardness levels. Five wells also tested for manganese above the EPA recommended level. The levels of hardness, manganese and iron do not represent a public health concern but may cause taste, oder and staining problems. Four wells tested for arsenic above the current EPA standard of 10.0 parts per billion, (ppb). The other parameters tested in 1995 EPA standards. There were, however, a couple wells tested that proved to deviate significantly from most parameter averages.

The objective of this updated study was to follow up the 1995 study and sample the groundwater in Bath Township again in order to see if there was a significant change in the water chemistry. However, the same wells which were sampled in 1995 were not always available to be sampled again for various reasons such as the well not existing anymore or homeowners simply not volunteering to participate in the study. A total of 22 wells which were spread evenly throughout the township were sampled.

Benefits for Bath Township

1. The updated survey will provide an accurate comparison to earlier water chemistry data to determine any trends that the groundwater or drinking water resource is making in respect to surface water pollution, surface and /or subsurface land activities.
2. Provide the community with an updated report on the condition of their sole source of drinking water and if any Public Health concerns need to be addressed. This may include levels of important main drinking water parameters such as arsenic, nitrates, boron, fluoride, and chloride test results.

3. Participating homeowners will receive their own individual extensive water test report which can be used to help manage and plan their individual water treatment needs, such as the operation of water softener devices or filters.
4. A presentation of the results and what it means for the community would be provided during a meeting at the Township Hall. This information can be used for future planning and management associated with the future protection of this important and exclusive resource for drinking water. The information can also be used in connection with Well Head Protection projects currently being done in the County.

How sampled wells with problem drinking water test results were addressed

Homeowners will each receive a copy of their individual test results that they can compare to the earlier testing in 1995. If a test result, or test results, indicate a drinking water concern and or exceed an established drinking water standard that represents a public health issue, the homeowner will be notified as soon as possible by phone or mail. The homeowner will be consulted about the test results and what are some options for correcting the drinking water concern.

For example, if the test results indicate an arsenic level above the drinking water standard of 10 ppb, they will be informed of the risks involved for drinking water with levels this high and the possible filtration devices available to treat the water. The goal is to inform the homeowner of the conditions of their drinking water resource. This would be analogous to having a blood test done by your family doctor and they find your cholesterol levels are too high. The doctor will then consult with the patient on the steps they should take to correct this concern. This will also be explained in a cover letter to the homeowner which will include some educational material on the test results. If homeowners still have further questions about the test results, there will be phone numbers and resources available for them to discuss the results with.

Results of the 2021 Survey

A total of 22 wells were sampled over the duration of the 2021 study. 12 of these wells were wells also sampled in the original 1995 study. The remaining 10 well locations sampled in the 2021 study were placed throughout Bath Township. Bacteria presence was tested in the 2021 study and was found in only four wells. However, of these four wells, E. Coli was not present.

Various water chemistry parameters were also tested from the samples collected in order to assess the groundwater quality. Average values from both the 1995 survey and 2021 survey of primary parameters were calculated. In addition, statistical analysis of

the primary parameters of the 1995 study and 2021 study was performed to quantify the changes between the two data sets.

Table 1: Mean values and Mann-Whitney test results comparing 1995 and 2021 water chemistry data. All 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 significant difference and green indicates no significant difference between the 1995 and 2021 data.

Parameter	1995 Mean	2021 Mean	Mann-Whitney Z	P Value
Alkalinity	229.1	262.6	-3.28464	0.00104
Arsenic	0.0033	0.0028	2.02198	0.04338
Boron	0.55	0.688	-0.71665	0.47152
Calcium	61.7	76.2	-3.29318	0.001
Chloride	5.68	5.7	-3.17373	0.00152
Conductivity	374.0	542.0	-5.50285	<.00001
Fluoride	0.49	0.57	-1.70631	0.08726
Hardness	250.6	289.1	-2.61918	0.0088
Iron	0.63	0.52	-0.38392	0.70394
Magnesium	20.81	24.09	-1.88547	0.05876
Nitrate	<0.30	<0.10	-	-
pH	7.5	7.46	-0.33273	0.7414
Potassium	3.00	3.50	-1.2712	0.20408
Silica	4.85	10.5	-5.34928	<0.00001
Sodium	13.93	14.7	-0.87022	0.3843
Sulfate	21.1	38.4	-1.15176	0.25014

For 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 doesn't guarantee the parameter is completely absent from the sample. In both the 1995 study and 2021 study, nitrate was non-detectable in all well samples measured and therefore the mean was less than the reporting limit of 0.30 ppm and 0.10 for 1995 and 2021 respectively.

Reporting limits of arsenic, chloride and sulfate changed between the 1995 survey and the 2021 survey potentially affecting the results of the Mann-Whitney test for these parameters. Therefore, further analysis was performed on these three parameters after altering the 2021 data to reflect reporting limits from the 1995 data. All concentrations

below the 1995 reporting limit found in the 2021 data were replaced with the respective non-detectable values used in the 1995 data.

Table 2: Mann-Whitney test results comparing 1995 and 2021 water chemistry data based on 1995 reporting limits. All values are shown in parts per million (ppm). A red P Value indicates a significant difference and green indicates no significant difference between the 1995 and 2021 data.

Parameter	1995 RL	2021 RL	1995 Mean	2021 Mean	Mann-Whitney Z	P Value
Arsenic	0.005	0.001	0.0033	0.0033	3.40409	0.00068
Chloride	2	0.5	5.68	5.3	0.18769	0.8493
Sulfate	2	1	21.1	38.4	-1.15176	0.25014

Based on further analysis, the change in chloride concentrations was determined to be not significant, while arsenic and sulfate results remained similar to prior analysis. Arsenic changes were still significant between the two data sets and sulfate changes were still insignificant between the two data sets.

Significant changes in conductivity found from analysis may be attributed to either increased use of road salt over the years or water softener discharges. Home water softeners are often installed in houses in the area because of hard well water. Water softeners regenerate, discharging wastewater containing calcium, magnesium and iron removed from the hard water as well as excess sodium and chloride from the resin tank of the water softener. If this wastewater is discharged too close to the water supply well, it may impact the well water concentrations of chloride, sodium, magnesium or calcium. However, the reason for increased conductivity in this area is inconclusive based on chloride to bromide ratios and insignificant changes in chloride and sodium concentrations between the two years.

Arsenic was found in 10 of the wells sampled in 2021. Part of this increase in detectable arsenic levels is a result of lower reporting limits from new technologies over the years. Still, six wells contained arsenic levels higher than that of the 1995 reporting limit and two of these wells contained arsenic levels higher than the current EPA primary drinking water standard for arsenic in drinking water of 0.01 ppm or 10 ppb.

Results of both the 1995 study and the 2021 study indicate hard groundwater in the area. The average hardness level was about 290 ppm which is considered very hard as it is above 180 ppm. This is most likely a result of high levels of magnesium and calcium present in surrounding soil and rock in the area that dissolve into the groundwater. High levels of hardness are not a health concern but can be an inconvenience as it could

cause mineral buildup in piping or affect the efficiency of soaps. Similarly, iron concentrations in 14 of the wells sampled in 2021 were above the recommended limit of 0.30 ppm. Four wells tested for manganese above the recommended limit of 0.05 ppm. The levels of iron and manganese are also not a health concern but could affect the taste and odor of the water and cause discoloration and staining.

In addition to the primary parameters analyzed, other water chemistry parameters were tested to ensure safe drinking water based on the National Primary Drinking Water Regulations.

Table 3: Comparison of 2021 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	2021 Mean
Arsenic	0.010	0.0028
Barium	2.00	0.16
Cadmium	0.005	<0.001
Chromium	0.10	0.0021
Copper	*TT action level =1.30	0.0032
Fluoride	4.00	0.57
Lead	*TT action level =0.015	<0.0010
Mercury	0.002	<0.0002
Nitrate	10.00	<0.10
Selenium	0.050	<0.001
Nitrite	1.00	<0.10

*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.

Parameters were non-detectable for all wells sampled for cadmium, mercury, nitrate, selenium and nitrite. Only two wells sampled showed detectable levels of lead, however, these values were well below the EPA action level of 0.015 ppm. All other parameters tested, though detectable, were under the Primary Drinking Water Standards for all wells sampled in Bath Township. The average arsenic level in the township was below the EPA standard, however, as previously mentioned, arsenic was above the standards in two of the wells tested. These homeowners were contacted via phone or mail to discuss potential options to address these levels of arsenic.

Finally, Bath Township groundwater data was compared to that of Ingham County data collected from 2015 to 2020. The comparison revealed a significant difference in a majority of the primary parameters measured.

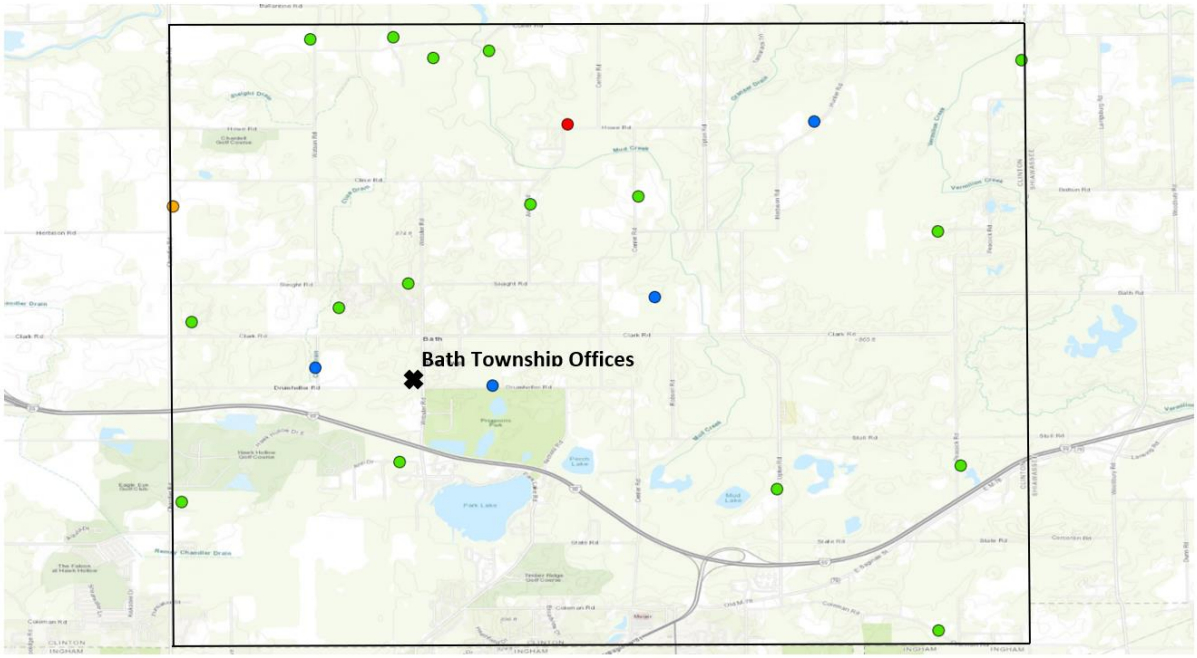
Table 4: Comparison of Bath Township data to Ingham County data. All values are shown in parts per million (ppm). A red P Value indicates a significant difference and green indicates no significant difference between the 1995 and 2021 data.

Parameter	2021 Bath Township Mean	2020 Ingham County Mean	Mann-Whitney Z	P Value
Alkalinity	262.6	325.4	4.79664	<0.00001
Arsenic	0.0028	0.0026	2.31284	0.02088
Boron	0.688	0.627	-2.53053	0.0114
Calcium	76.2	85.6	2.02522	0.04235
Chloride	5.7	33.3	2.42762	0.0151
Conductivity	542.0	797.7	5.60464	<0.00001
Fluoride	0.57	0.44	-3.93301	0.00008
Hardness	289.1	328.9	1.83919	0.06576
Iron	0.52	1.11	4.17841	<0.00001
Magnesium	24.09	26.18	1.22568	0.2187
Nitrate	<0.10	0.12	4.48978	<0.00001
pH	7.46	7.40	-2.00938	0.04444
Potassium	3.50	2.95	-2.47116	0.01352
Silica	10.5	12.4	1.95793	0.05
Sodium	14.7	42.2	0.64912	0.5157
Sulfate	38.4	51.1	0.88133	0.37886

Table 5: Comparison of 2021 Bath Township survey data with 2020 Ingham County survey data and 2021 Dewitt Township survey data. All values are in parts per million (ppm).

Parameter	2021 Bath Township Mean	2020 Ingham County Mean	2021 Dewitt Township Mean
Alkalinity	262.6	325.4	298.24
Arsenic	0.0028	0.0026	0.0050
Boron	0.688	0.627	0.267
Calcium	76.2	85.6	77.47
Chloride	5.7	33.3	12.70
Conductivity	542.0	797.7	571.00
Fluoride	0.57	0.44	0.44
Hardness	289.1	328.9	307.06
Iron	0.52	1.11	0.89
Magnesium	24.09	26.18	27.94
Nitrate	<0.10	0.12	-0.10
pH	7.46	7.40	7.48
Potassium	3.50	2.95	2.46
Silica	10.5	12.4	12.79
Sodium	14.7	42.2	13.34
Sulfate	38.4	51.1	23.39

Bath Township Well Testing Sites



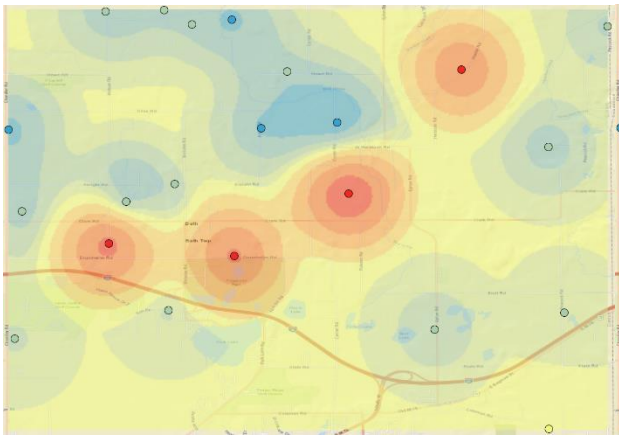
Average Well Chemistry

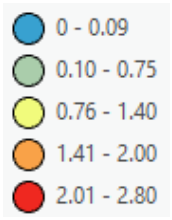
Above Average Boron Levels

Arsenic Above 10 ppb Standard

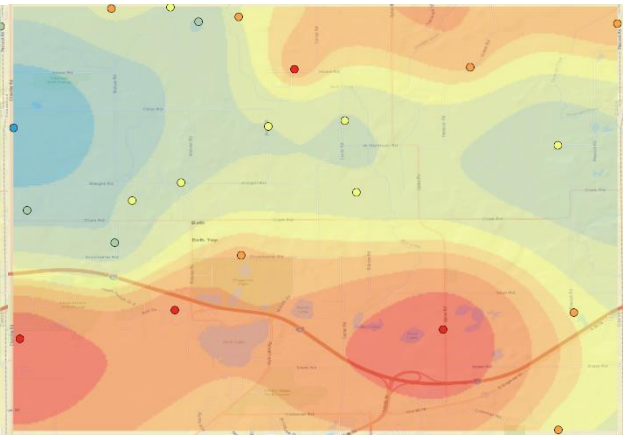
Arsenic Above 10 ppb Standard and Above Average Chloride Levels

Boron Levels for Bath Township

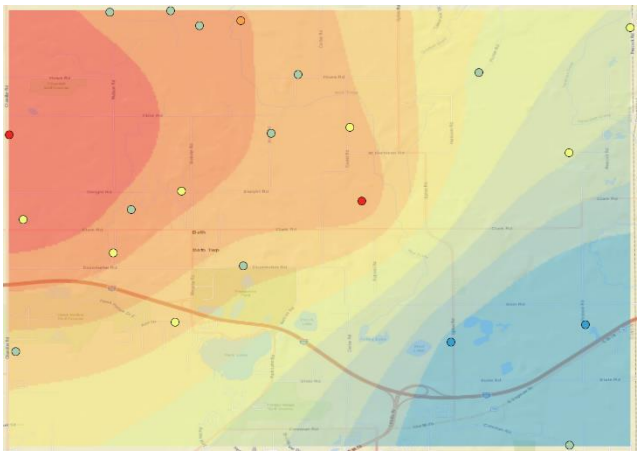




pH Levels for Bath Township



Hardness Levels for Bath Township



These three maps show the distribution of boron, pH, and water hardness in Bath Township groundwater. The water quality data to create these chemistry level or topographic maps used data from the 22 wells sampled in 2021.

References

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Acknowledgements

This project would like to thank Garry Rowe for his important contribution to the organization and execution of this project. The project would not have been possible without his assistance with field work, data analysis and development of the Bath Township Water Quality Report.

This project would also like to thank Dr. Susan Masten for her significant support throughout the project and contribution to the data analysis.

In addition, this project acknowledges the important contributions of the Lansing Board of Water and Light, Eaton Analytical and Merit Laboratories Inc. Lansing Board of Water and Light provided critical laboratory analysis and results for well samples provided. Eaton Analytical and Merit Laboratories Incorporated provided additional analysis of water chemistry parameters.

Finally, this study would not have been possible without the support from Bath Township and the willingness of the homeowners who participated in the study.

GROUNDWATER QUALITY REPORT

FOR

BATH TOWNSHIP 1995/2021

EMILY RENN B.S., SARA NEVEDAL, RYAN BROWN

GARRY ROWE, R.S., M.S.

AUGUST 16, 2021

Appendix

1

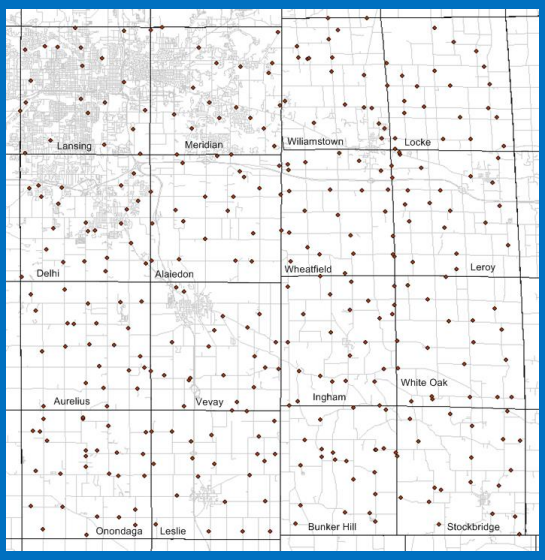
Groundwater Quality Assessment

Bath Township

2

INGHAM COUNTY WELLS TESTED FOR THE 80's SURVEY

- Ingham County participates with the Michigan Groundwater Survey (MGS) 1983
- 312 wells sampled
- Approximately 20 per township
- Survey and report completed in 1988



3

4

Sample Constituents

Major Ions
- Calcium
- Magnesium
- Sodium
- Chloride
- Sulfate
- Fluoride
- Potassium

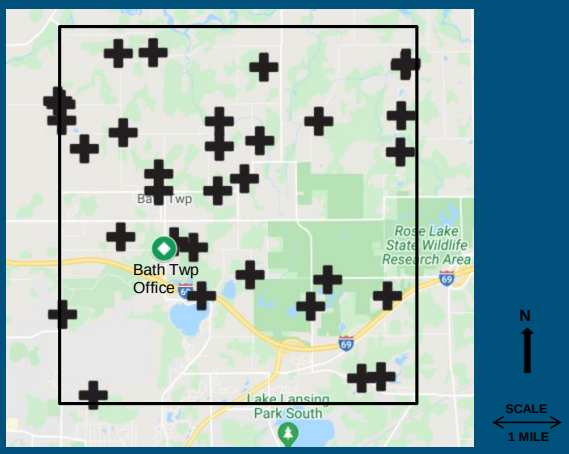
Nutrients
- Nitrate

Trace Metals
- Arsenic
- Barium
- Cadmium
- Chromium
- Copper
- Iron
- Lead
- Mercury
- Zinc

Other Parameters
- Alkalinity
- Boron
- Bromide
- Conductance
- pH
- Selenium
- Silica
- Temperature
- Total Dissolved Solids
- Water Hardness

5

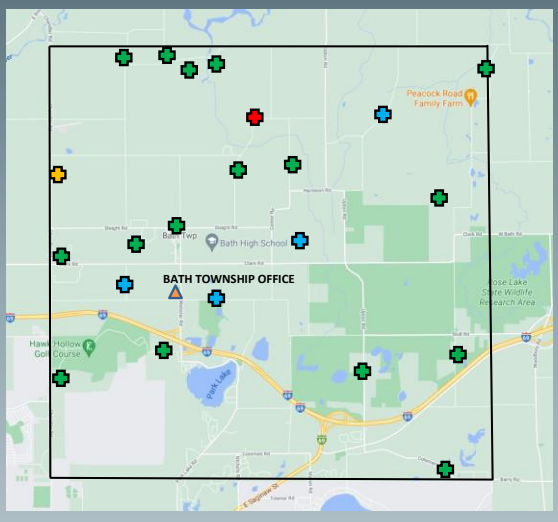
Bath Township Wells Tested For 1995 Survey



32 Wells Sampled

6

BATH TOWNSHIP WELL TESTING SITES



- AVERAGE WELL WATER CHEMISTRY
- BORON LEVEL AT 1.0 PPM OR ABOVE
- ARSENIC AT OR ABOVE EPA STANDARD OF 10.0 PPB
- ARSENIC AT OR ABOVE EPA STANDARD OF 10.0 PPB AND ABOVE AVERAGE CHLORIDE LEVELS

7

Comparing 1995 Data and 2021 Data

Parameter	1995 Mean	2021 Mean	Mann-Whitney Z	P Value
Alkalinity	229.1	262.6	-3.28464	0.00104
Arsenic	0.0033	0.0028	2.02198	0.04338
Boron	0.55	0.688	-0.71665	0.47152
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pH	7.5	7.46	-0.33273	0.7414
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Sodium	13.93	14.7	-0.87022	0.3843
Sulfate	21.1	38.4	-1.15176	0.25014

P values shown in RED represent a significant difference between the 1995 data and 2021 data

8

Comparing Bath Twp Data with Ingham County Data

Parameter	2021 Bath Township Mean	2020 Ingham County Mean	Mann-Whitney Z	P Value
Alkalinity	262.6	325.4	4.79664	<0.00001
Arsenic	0.0028	0.0026	2.31284	0.02088
Boron	0.688	0.627	-2.53053	0.0114
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Iron	0.52	1.11	4.17841	<0.00001
Magnesium	24.09	26.18	1.22568	0.2187
Nitrate	<0.10	0.12	4.48978	<0.00001
pH	7.46	7.40	-2.00938	0.04444
Potassium	3.50	2.95	-2.47116	0.01352
Silica	10.5	12.4	1.95793	0.05
Sodium	14.7	42.2	0.64912	0.5157
Sulfate	38.4	51.1	0.88133	0.37886

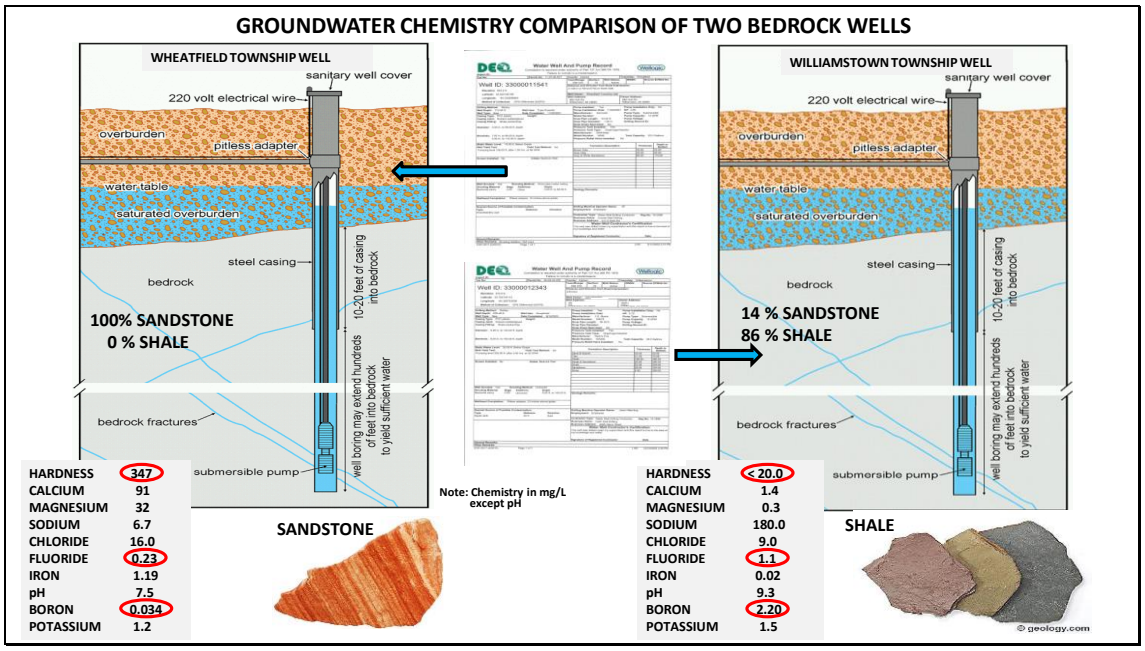
P values shown in RED represent a significant difference between the Bath Twp data and Ingham County data

9

Comparing Bath Twp Data with Dewitt Twp and Ingham County Data

Parameter	2021 Bath Township Mean	2020 Ingham County Mean	2021 Dewitt Township Mean
Alkalinity	262.6	325.4	298.24
Arsenic	0.0028	0.0026	0.0050
Boron	0.688	0.627	0.267
Calcium	76.2	85.6	77.47
Chloride	5.7	33.3	12.70
Conductivity	542.0	797.7	571.00
Fluoride	0.57	0.44	0.44
Hardness	289.1	328.9	307.06
Iron	0.52	1.11	0.89
Magnesium	24.09	26.18	27.94
Nitrate	<0.10	0.12	-0.10
pH	7.46	7.40	7.48
Potassium	3.50	2.95	2.46
Silica	10.5	12.4	12.79
Sodium	14.7	42.2	13.34
Sulfate	38.4	51.1	23.39

10



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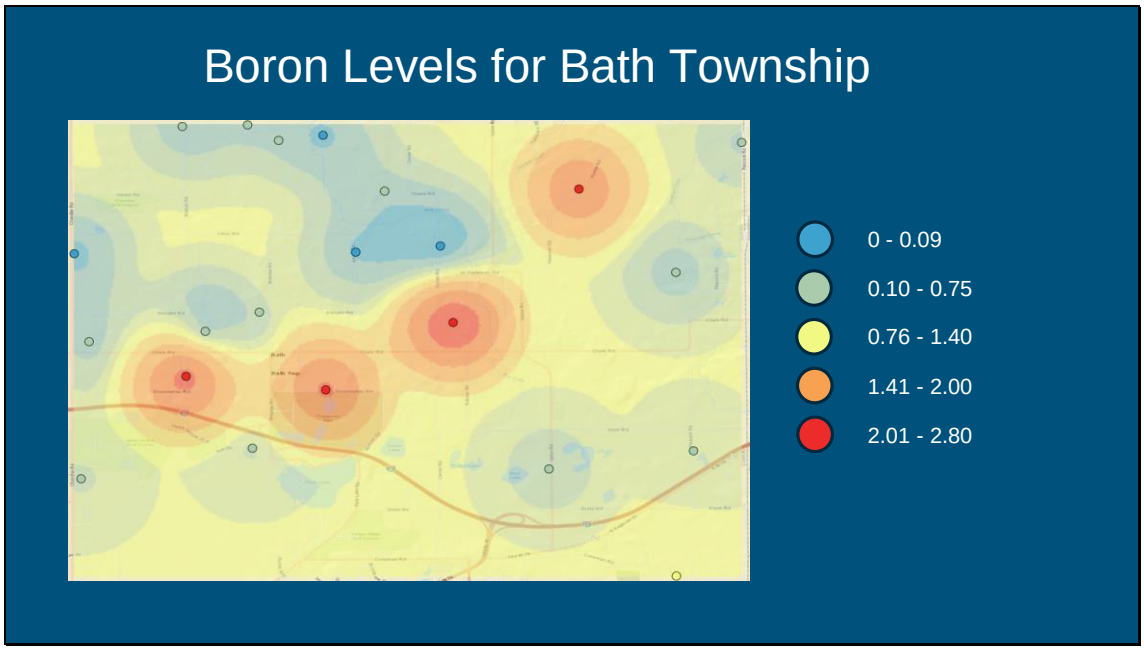
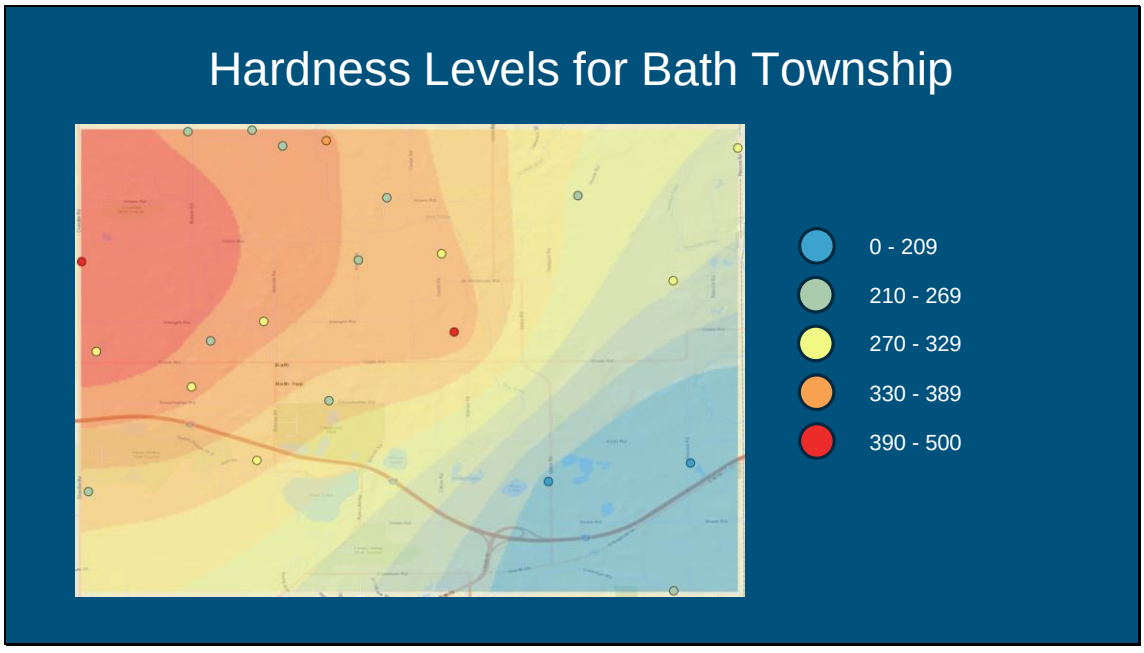

Boron Levels for Bath Township
0 - 0.09
0.10 - 0.75
0.76 - 1.40
1.41 - 2.00
2.01 - 2.80

12


Hardness Levels for Bath Township
0 - 209
210 - 269
270 - 329
330 - 389
390 - 500

13

RECOMMENDATIONS:

HOMEOWNERS NEED TO ROUTINELY CHECK THE PHYSICAL CONDITION OF THEIR WELL, SUCH AS THE WELL CAP AND CASING. WELLS THAT ARE ABANDONED OR ARE NO LONGER IN SERVICE SHOULD BE PROPERLY SEALED BY A LICENSED WELL DRILLING COMPANY.

WELLS SHOULD ALSO BE ROUTINELY TESTED FOR A BACTERIOLOGICAL AND PARTIAL CHEMICAL ANALYSIS, WHICH INCLUDES SULFATE AND FLUORIDE, WHICH MAY BE HIGH IN CERTAIN LOCATIONS. TESTS FOR BOTH ARSENIC AND BORON SHOULD BE CONSIDERED. FOR HOMEOWNERS IN THE WILLIAMSTON AND SURROUNDING AREA, TESTS FOR BOTH FLUORIDE AND BORON WOULD BE IMPORTANT.

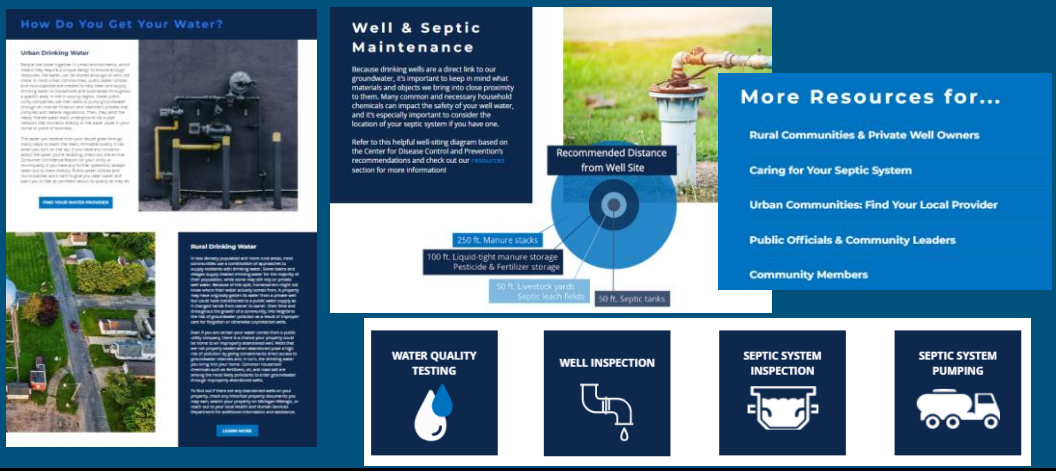
THE USE OF DE-ICING SALT PRODUCTS SHOULD BE REVIEWED FOR POSSIBLE EFFECTS ON BOTH SURFACE AND GROUNDWATER RESOURCES. HOMEOWNERS NEED TO MANAGE WASTEWATER FROM WATER TREATMENT DEVICES PROPERLY SO THAT WELLS AND GROUNDWATER ARE NOT ADVERSELY IMPACTED. ALTERNATIVES FOR ROAD TREATMENT SHOULD ALSO BE EXPLORED.

RESOURCES SHOULD BE MADE AVAILABLE TO CONDUCT A SURVEY OF THE GROUNDWATER/DRINKING WATER EVERY 10 YEARS.

14

Groundwater Management Board WEBPAGES

mitcrpc.org/migroundwater



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Thank you for your time
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CHECK US OUT ONLINE
mitrcpc.org/migroundwater
EMAIL US
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