MCD Report 2021-17

MIAMI CONSERVANCY DISTRICT

2021 Groundwater Quality Survey and Contaminant Trends

Study Report

MCD staff member Maya Canaztuj collects a groundwater sample from a monitoring well in Clark County, Ohio

Executive Summary

To study groundwater quality, MCD staff collected samples from 12 monitoring wells installed throughout the buried valley aquifer system of the Great Miami River Watershed during the spring and fall of 2021. This study is part of an ongoing groundwater quality characterization program started in 2014. The goal of the program is to better understand human impact on the groundwater in the aquifer system, and identify contaminant trends. The groundwater samples were analyzed for baseline parameters including the presence of *E. coli*, major ions, metals, and nutrients. Samples were also analyzed for volatile organic compounds from a monitoring well with a history of trichloroethene detections.

Overall, the groundwater sampled during this study has a calcium-magnesium-bicarbonate composition and measured water hardness in the very hard range.

Samples collected from 7 of the 12 monitoring wells met all human-health benchmarks. The parameters detected in at least one groundwater sample that equaled or exceeded a human-health benchmark include arsenic, *E. coli*, lithium, manganese, and nitrate. Parameters detected in at least one groundwater sample that exceeded secondary drinking water standards include aluminum, iron, manganese, and total dissolved solids.

The parameters detected that may be indicative of anthropogenic (human) sources of contamination include chloride, nitrate, sodium, and trichloroethene. Naturally occurring contaminants detected include arsenic, iron, hardness, manganese, and total dissolved solids.

When compared with previous studies, the level of trichloroethene declined in the groundwater sample pulled from the monitoring well with a history of detections. Nitrate concentrations detected in the samples vary widely among the monitoring wells. The nitrate concentrations collected from the monitoring wells with a history of elevated nitrate concentrations illustrate seasonal, as well as temporal, fluctuations in concentration values. Concentrations of chloride and sodium also vary widely among the monitoring wells and demonstrate significant fluctuations throughout the sampling history in wells with elevated concentrations. Concentrations of naturally occurring contaminants such as arsenic, iron, and manganese tend to be fairly consistent throughout the sampling history of most monitoring wells not showing strong evidence of increasing or decreasing trends.

The results of this study are similar to previous studies. Low levels of anthropogenic contaminants are common in sensitive, shallow sand and gravel aquifer settings. This emphasizes the need for groundwater protection strategies to manage the quality of buried valley aquifer resources in southwest Ohio.

Introduction

Since 2014, MCD has conducted an ongoing groundwater monitoring program in the Great Miami River Watershed. The purpose of the program is to provide a better understanding of the impact of human activities on groundwater quality. In 2021, MCD staff collected samples from 12 groundwater monitoring wells to survey groundwater quality in the buried valley aquifer (see Figure 1). All of the wells included in the study are surrounded by land uses with the potential to release contaminants into the aquifer. Groundwater quality monitoring has been conducted by MCD staff twice per year since 2014 at monitoring wells BUT10014, BUT10016, CLA10018, and MON10016. The other eight monitoring wells have been sampled since 2015 or 2016.

The wells selected for the study are installed in unconfined sand and gravel aquifers with permeable soils at the surface. Eight of the wells (BUT10014, BUT10016, BUT10017, CLA10011, MON00022, MON10016, WAR10003, and WAR10004) are situated within 400 feet of a river or lake and a comparison of static water level measurements for those wells with nearby stream gage data suggests hydraulic interactions occur between the aquifer and the river. Seven of the wells are screened at shallow (< 50 feet) depths. Table 1 summarizes depths and screened intervals for all of the monitoring wells in this survey.

MCD equipped each monitoring well with a bladder pump installed within the screened interval of the well. The bladder pumps allow low-flow purging techniques to be used (Puls and Barcelona, 1996).

MCD staff collect groundwater samples twice each year. The samples are analyzed for *Escherichia coli (E. coli)*, major ions, metals, nutrients, and in the case of monitoring well BUT10014, volatile organic compounds (VOCs). These parameters are measured every sampling event to provide a baseline for groundwater quality. Additional parameters including VOCs, semivolatile organic compounds (SVOCs), and pharmaceuticals are analyzed on a less frequent basis to provide additional data on groundwater quality.

Table 1 – Construction details for groundwater quality monitoring wells

Monitoring Well ID	Casing Diameter (in)	Well Depth (ft)	Screened Interval (ft)	Aquifer Screened	Distance to River or Lake (ft)
BUT10014	2	40	35 - 40	Sand and Gravel	120
BUT10016	2	65	60 - 65	Sand and Gravel	120
BUT10017	2	39	34 - 39	Sand and Gravel	120
CLA10011	2	60	55 - 60	Sand and Gravel	135
CLA10018	2	16	11 - 16	Sand and Gravel	2,810

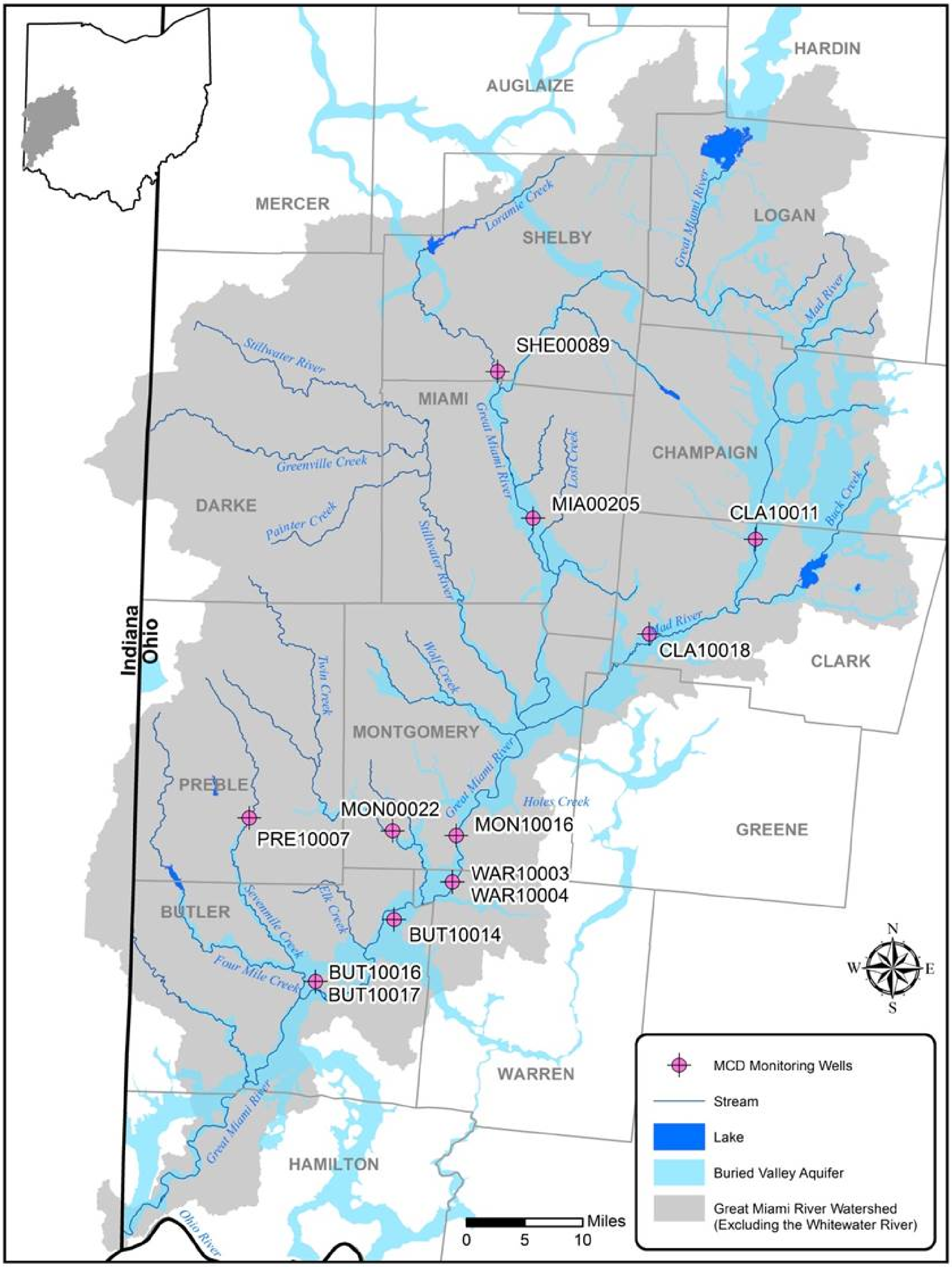
Monitoring Well ID	Casing Diameter (in)	Well Depth (ft)	Screened Interval (ft)	Aquifer Screened	Distance to River or Lake (ft)
MIA00205	2	24	19 - 24	Sand and Gravel	1,130
MON00022	2	15	10 - 15	Sand and Gravel	110
MON10016	2	108	88 - 108	Sand and Gravel	355
PRE10007	2	60	40 - 60	Sand and Gravel	960
SHE00089	2	43	38 - 43	Sand and Gravel	600
WAR10003	2	67	62 - 67	Sand and Gravel	85
WAR10004	2	32.5	27.5 – 32.5	Sand and Gravel	90

MCD staff collected duplicate samples from one monitoring well during each sampling event to evaluate laboratory precision. Field blanks were also collected to assess potential contamination from field conditions during sampling.

MCD staff compared the results of this study with federal drinking water standards and human health-based screening levels. Drinking water standards are generally more stringent than other water standards, so when groundwater meets drinking water standards it should be suitable for other uses.

National Primary Drinking Water Regulations for parameters are legally enforceable standards set by the U.S. EPA that apply to public water systems. Primary standards set maximum contaminant levels (MCLs) that help protect public health by limiting the contaminant concentrations in drinking water. National Secondary Drinking Water Standards are advisable guidelines addressing secondary maximum contaminant levels (SMCLs) that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. The U.S. EPA recommends, but does not require, that public water systems incorporate secondary standards. The U.S. EPA Office of Water also publishes non enforceable health-based screening levels (HBSLs) for some constituents which may pose potential human-health concerns but do not yet have an enforceable standard. HBSLs are used as a supplement for evaluating contaminants in drinking water in a human-health context. For the purpose of this study MCD refers to all MCLs and HBSLs as human-health benchmarks to be used for interpreting analytical results.

Figure 1 – Locations of monitoring wells



2021 Results

In 2021, MCD collected samples twice; once between May 21 and June 4 (spring) and once between September 9 and 15 (fall). Sampling results for 2021 are generally similar to results from previous years. Analysis of major ions (cations and anions) in groundwater samples show the dominant cation is calcium with significant quantities of magnesium and sodium also present. The average calcium concentration of groundwater samples was 90 mg/L. The dominant anion was bicarbonate with lesser amounts of chloride and sulfate. Bicarbonate content was estimated using alkalinity and pH measurements for each sample. The average bicarbonate concentration in groundwater samples was 326 mg/L. A piper diagram of major cations and anions shows the groundwater has a calcium-magnesium-bicarbonate composition (see Figure 2). Calcium-magnesium-bicarbonate groundwater tends to be present in areas where carbonate rocks comprise a significant amount of the aquifer matrix.

Groundwater samples collected at monitoring wells BUT10014, BUT10017, CLA10011, MIA00205, SHE00089, WAR10003 and WAR10004 met all human-health benchmarks including MCLs and HBSLs for both sampling events (see Table 2). See Appendix A for a complete list of all analytical parameters, analytical methods, and results.

Parameters Exceeding Human-Health Benchmarks

At least one parameter occurred at a concentration exceeding human-health benchmarks in 3 of the 12 monitoring wells (BUT10016, MON10016, and PRE10007) for the spring sampling event. Concentrations of at least one parameter also exceeded human-health benchmarks in 3 of 12 monitoring wells (BUT10016, CLA10018, and MON00022) for the fall sampling event. The parameters arsenic, *E. coli*, lithium, manganese, and nitrate were detected in at least one sample at concentrations exceeding human health based benchmarks in 2021. Arsenic, *E. coli*, and nitrate have MCLs while lithium and manganese have HBSLs. Manganese also has a SMCL.

- The arsenic concentration (26.8 µg/L) in the spring groundwater sample collected from monitoring well PRE10007 exceeded the MCL of 10 µg/L, but the concentration (5.9 µg/L) measured in the fall sample fell below this level.

- *E. coli* was present at 12.8 MPN/100mL in the spring groundwater sample collected from monitoring well MON10016. The MCL for *E. coli* is 0 MPN/100 mL. *E. coli* was not detected in any of the groundwater samples collected during the fall.

- Lithium exceeded the HBSL of 10 µg/L in the fall (12.2 µg/L) groundwater sample collected from monitoring well MON00022. The concentration (9.5 µg/L) measured in the groundwater sample collected from MON00022 during the spring fell below this benchmark.

- Manganese exceeded the HBSL of 0.3 mg/L in both the spring (0.408 mg/L) and fall (0.378 mg/L) groundwater samples collected from monitoring well BUT10016.

Figure 2 – Piper diagram illustrating dominant cations, anions, and water type of samples

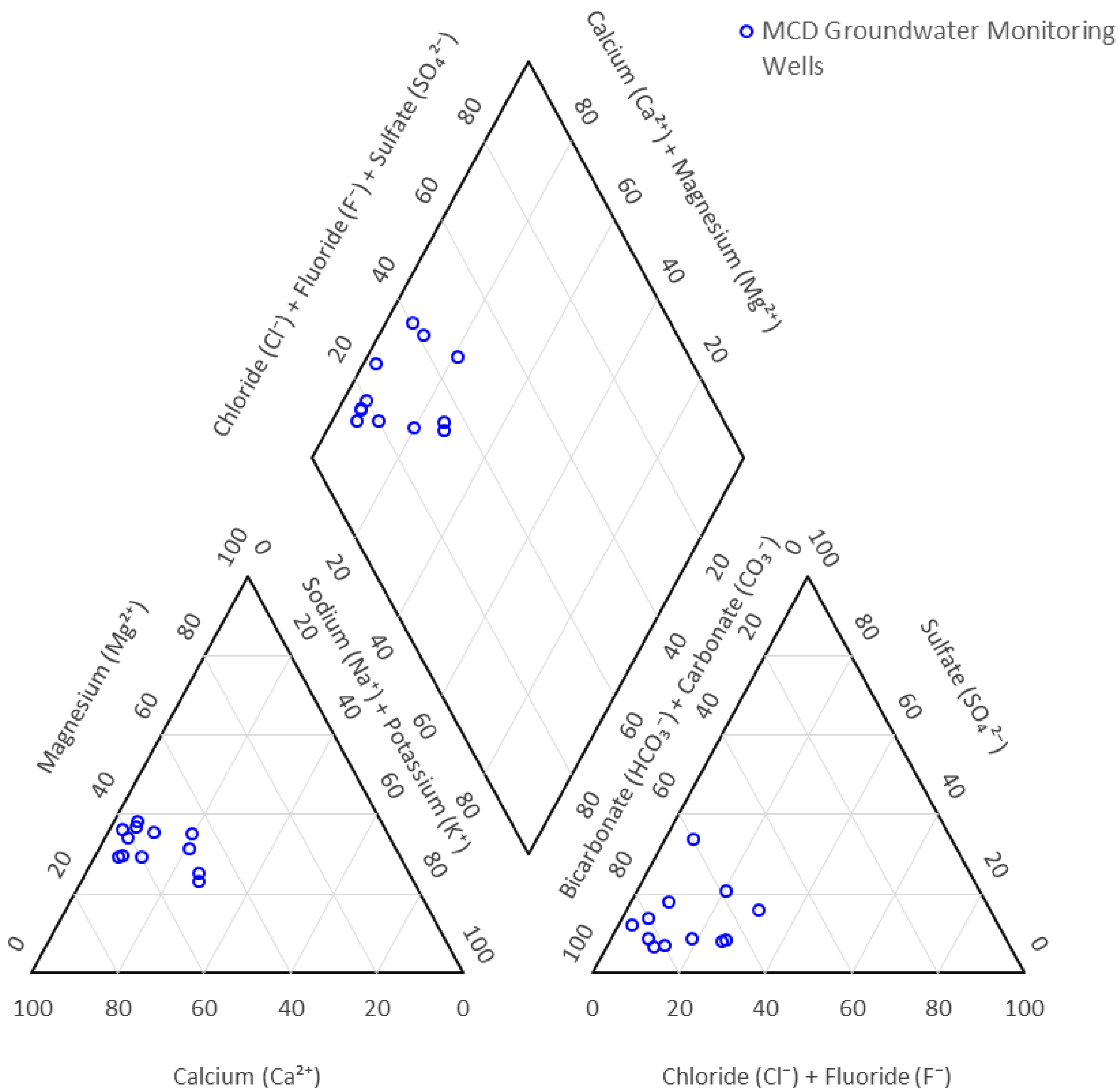


Table 2 – Summary of significant detections of constituents in groundwater

Spring 2021		**Benchmark**		**Sample Sites**					
Parameter	**Units**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Chloride	mg/L	SMCL	250	94.5					
Nitrate	mg/L	MCL	10			6.4		9.5	3.3
Sodium	mg/L	-	-	65.6					
E. coli	MPN/100mL	MCL	0						
Trichloroethene	µg/L	MCL	5	1.3					
Aluminum	µg/L	HBSL, SMCL	6,000, 200	**2,670**					
Arsenic	µg/L	MCL	10		4.1		7.1		
Iron	mg/L	HBSL, SMCL	4, 0.03		**1.64**		**2.88**		
Lithium	µg/L	HBSL	10						
Manganese	mg/L	HBSL, SMCL	0.3, 0.05		**0.408**		**0.060**		**0.055**
Total Dissolved Solids	mg/L	SMCL	500	**532**					
Total Hardness	mg/L	-	-	399	306	330	402	318	**NA**
Parameter	**Units**	**Type**	**Value**	**MON00022**	**MON10016**	**PRE10007**	**SHE00089**	**WAR10003**	**WAR10004**
Chloride	mg/L	SMCL	250		75.1			113.0	
Nitrate	mg/L	MCL	10						
Sodium	µg/L	-	-		46.2			50.5	
E. coli	MPN/100mL	MCL	0		**12.8**				
Trichloroethene	µg/L	MCL	5						
Aluminum	µg/L	HBSL, SMCL	6,000, 200					**602**	**1,240**
Arsenic	µg/L	MCL	10			**26.8**			
Iron	mg/L	HBSL, SMCL	4, 0.03		**0.364**	**8.66**		**2.08**	
Lithium	µg/L	HBSL	10	9.5		5.4		5.6	
Manganese	mg/L	HBSL, SMCL	0.3, 0.05		**0.073**		**0.275**	**0.063**	
Total Dissolved Solids	mg/L	SMCL	500	**742**				**604**	
Total Hardness	µg/L	-	-	582	294	357	359	430	260

Numbers in bold exceed a benchmark
NA – Parameter was not analyzed

Table 2 continued – Summary of significant detections of constituents in groundwater continued

Fall 2021		**Benchmark**		**Sample Sites**					
Parameter	**Units**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Chloride	mg/L	SMCL	250	83.6					
Nitrate	mg/L	MCL	10			6.6		**10**	3.5
Sodium	mg/L	-	-	61.0					
Arsenic	µg/L	MCL	10		7.7		8.8		
Iron	mg/L	HBSL, SMCL	4, 0.3		**1.56**		**2.99**		
Lithium	µg/L	HBSL	10						
Manganese	mg/L	HBSL, SMCL	0.3, 0.05		**0.378**		**0.059**		**0.089**
Total Dissolved Solids	mg/L	SMCL	500	**526**					
Total Hardness	µg/L	-	-	344	280	298	392	308	335
Parameter	**Units**	**Type**	**Value**	**MON00022**	**MON10016**	**PRE10007**	**SHE00089**	**WAR10003**	**WAR10004**
Chloride	mg/L	SMCL	250		69.2			125.0	
Nitrate	mg/L	MCL	10						
Sodium	mg/L	-	-		48.4			48.9	
Arsenic	µg/L	MCL	10			5.9		2.8	
Iron	mg/L	HBSL, SMCL	4, 0.3		**0.326**	**2.16**		**1.98**	
Lithium	µg/L	HBSL	10	**12.2**				5.7	
Manganese	mg/L	HBSL, SMCL	0.3, 0.05		**0.073**		**0.276**	**0.057**	
Total Dissolved Solids	mg/L	SMCL	500	**624**				**598**	
Total Hardness	mg/L	-	-	540	305	358	346	401	241

Numbers in bold exceed a benchmark
NA – Parameter was not analyzed

- Nitrate was detected at a concentration of 10 mg/L in the groundwater sample collected from monitoring well CLA10018 during the fall sampling event. This concentration equals the MCL of 10 mg/L. Nitrate was also detected in the groundwater sample collected during the spring event at a 9.5 mg/L, just below the MCL.

Parameters Exceeding Secondary Drinking Water Standards

At least one parameter exceeded an SMCL in samples collected from 10 of the 12 monitoring wells for the spring event and 9 of the 12 wells for the fall event (see Table 2). Parameters present at concentrations exceeding SMCLs included aluminum, iron, manganese, and total dissolved solids.

- Aluminum was detected at concentrations above the SMCL (200 µg/L) in the spring groundwater samples collected from monitoring wells BUT10014, WAR10003, and WAR10004. However, aluminum was not detected in any groundwater samples collected during the fall sampling event.

- Iron was detected at concentrations above the SMCL (0.3 mg/L) in fall and spring groundwater samples collected from monitoring wells BUT10016, CLA10011, MON10016, PRE10007, and WAR10003.

- The SMCL for Manganese is 0.05 mg/L. Measured concentrations of manganese in groundwater samples collected from monitoring wells BUT10016, CLA10011, MIA00205, MON10016, SHE00089, and WAR10003 exceeded this standard for both sampling events.

- Total dissolved solids measured in groundwater samples collected from monitoring wells BUT10014, MON00022, and WAR10003 exceeded the SMCL of 500 mg/L for both sampling events.

Parameters Indicative of Anthropogenic Sources of Contaminants

The parameters detected in groundwater samples at concentrations that likely reflect anthropogenic sources include chloride, nitrate, sodium, and trichloroethene. Chloride and sodium are present in groundwater naturally, but human activities can elevate their concentration significantly above natural levels. Likewise, nitrogen in the form of nitrate can be naturally present in groundwater, but anthropogenic sources of nitrogen can elevate nitrate concentrations above levels that would be present in the absence of human activities. Trichloroethene is a manufactured compound that cannot be found in nature in the absence of anthropogenic sources. A summary of the parameters detected in at least one groundwater sample and believed to reflect anthropogenic sources of contaminants follows.

Chloride and Sodium
Chloride has an SMCL of 250 mg/L. There are no human health based benchmarks for sodium in drinking water. Background levels of chloride in the buried valley aquifer system typically do

not exceed 50 mg/L (Spieker, 1968), and (Debrewer et al, 2000). Kunz and Sroka (2004) reported mean background concentrations of chloride ranging from 13 to 23 mg/L in shallow unconsolidated aquifers in Champaign, Clark, and Pickaway counties in Ohio. Chloride concentrations above 70 mg/L and sodium concentrations above 43 mg/L in local sand and gravel aquifers likely reflect anthropogenic sources (Kunz and Sroka, 2004; Ohio EPA, 2015). These concentrations are higher than what is typically measured in groundwater samples collected from sand and gravel aquifers in Ohio (Ohio EPA, 2015).

Chloride concentrations measured in groundwater samples from monitoring wells BUT10014, MON10016 and WAR10003 exceeded 70 mg/L in at least one sampling event in 2021 and likely reflect anthropogenic sources. Sodium concentrations in groundwater samples from monitoring wells BUT10014, MON10016, and WAR10003 exceeded 43 mg/L for both sampling events and also likely reflect anthropogenic sources. Anthropogenic sources of chloride and sodium include road salt applications for deicing and private and municipal wastewater from homes with water softeners.

Nitrate

According to Madison and Brunett (1985), nitrate concentrations in excess of 3.0 mg/L in groundwater are often indicative of anthropogenic sources. Nitrate concentrations measured in groundwater samples during the spring and fall sampling events for monitoring wells BUT10017, CLA10018, and MIA00205 exceeded 3.0 mg/L. Common sources of nitrate in groundwater include fertilizers, domestic or municipal wastewater, and animal waste or manure applied as fertilizer. Monitoring well CLA10018 is particularly vulnerable to sources of nitrate. The well is located in the middle of an agricultural field used for corn and soybean production and screened in sand and gravel at a depth of 11 feet.

Analysis of nitrogen and oxygen isotopes measured in groundwater samples collected from BUT10017 and CLA10018 in 2017 and 2018 suggested an inorganic fertilizer source for the nitrate present in those wells (Bedaso and Ekberg, 2019).

Trichloroethene (TCE)

TCE is a volatile organic compound used primarily to remove grease from fabricated metal parts. The MCL for trichloroethene is 5 µg/L. TCE was detected in the spring groundwater sample collected from monitoring well BUT10014 at a concentration of 1.3 µg/L. It was not detected in the fall groundwater sample. Well BUT10014 is located at Smith Park in Middletown close to the former Aeronca Air Products site, a site which underwent environmental cleanup activities (Robinson and Richter, 2012). A TCE contaminant plume is present in the aquifer south of the site including the area in which BUT10014 is located. The City of Middletown and Ohio EPA have been tracking the extent of the TCE contamination in recent years (J. Smindak, Ohio EPA, personal communication, September 8, 2017).

Naturally Occurring Contaminants

Arsenic

Arsenic occurs naturally in regional groundwater and concentrations of arsenic are largely controlled by redox conditions. The dominant mechanism for moving arsenic into groundwater is thought to be the release of arsenic from iron oxides in the aquifer under reducing conditions (Thomas et al, 2008). The MCL for arsenic is 10 µg/L. Groundwater samples collected from monitoring wells BUT10016, CLA10011, PRE10007, and WAR10003 had detectable concentrations of arsenic in at least one of the two 2021 sampling events. The concentration of arsenic measured in the spring groundwater sample collected from monitoring well PRE10007 exceeded the MCL. It should be noted groundwater samples from all of these wells had elevated levels of iron, low levels of dissolved oxygen, and negative oxidation reduction potentials indicating reducing conditions present in the aquifer zone in which the wells are screened.

Lithium
Lithium is a metal that occurs naturally in groundwater that comes into contact with lithium containing minerals or saline water. The HBSL for lithium is 10 µg/L. At least one groundwater sample collected from monitoring wells MON00022, PRE10007, and WAR10003 had detectable concentrations of lithium. The lithium concentration measured in the fall groundwater sample collected from monitoring well MON00022 (12.2 µg/L) exceeded the HBSL.

Nuisance Contaminants
Hardness, iron, manganese, and total dissolved solids are generally considered to be "nuisance" contaminants. These contaminants are present naturally in groundwater from the buried valley aquifer system. Their presence does not typically pose a health threat. Nevertheless, they can have adverse aesthetic impacts that cause water to appear cloudy or colored. They can also adversely impact plumbing fixtures, stain laundry, and cause taste and odor issues. At high enough concentrations manganese may pose health concerns. In 2004, U.S. EPA issued a lifetime health advisory level of 0.3mg/L for manganese in drinking water.

Hardness is a measure of the amount of dissolved calcium and magnesium in a water sample. When the hardness value exceeds 180 mg/L the water is considered to be very hard. All groundwater samples collected in 2021 had hardness values exceeding 180 mg/L. There is no SMCL for water hardness.

The SMCL for Iron is 0.3 mg/L. Iron concentrations measured in samples collected from monitoring wells BUT10016, CLA10011, MON10016, PRE10007, and WAR10003 exceeded this standard in both sampling events.

The SMCL for manganese is 0.05 mg/L. Manganese concentrations in groundwater samples collected from monitoring wells BUT10016, CLA10011, MIA00205, MON10016, SHE00089, and WAR10003 exceeded this standard during both sampling events. Manganese also has a lifetime health advisory level of 0.3 mg/L. Both groundwater samples collected from well BUT10016 in 2021 exceeded this standard.

Total dissolved solids (TDS) are comprised of inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates). TDS is the sum of cations and anions in a water sample. The SMCL for TDS is 500 mg/L. Groundwater samples collected from wells BUT10014, MON10016, and WAR10003 exceeded this standard for both sampling events.

Contaminant Trends

Groundwater quality data collected during this study was analyzed for trends in contaminant concentrations. MCD selected the chemical parameters chloride, nitrate, sodium, and TCE as parameters indicative of anthropogenic sources. The parameters arsenic, iron, lithium, and manganese were selected to examine trends in naturally occurring contaminant concentrations.

Contaminants Indicative of Anthropogenic Sources

Chloride and Sodium

Chloride concentrations measured in samples collected from monitoring wells BUT10014, MON10016 and WAR10003 are consistently higher than 70 mg/L and above the concentrations measured in samples from the other monitoring wells (see figure 3). Chloride concentrations in samples show fluctuations from sampling event to sampling event. Likewise, sodium concentrations measured in the three wells (BUT10014, MON10016, and WAR10003) were above concentrations measured at other monitoring wells (see figure 4). Sodium concentrations show similar fluctuations as chloride. Seasonal fluctuations in chloride and sodium are often more pronounced in wells with the highest concentrations of those parameters. These fluctuations may reflect infiltration of saline water from snow melt and rainfall events after seasonal applications of road salt.

Nitrate

Nitrate concentrations measured at monitoring wells BUT10017, CLA10018 and MIA00205 consistently exceed 3 mg/L and likely reflect anthropogenic sources of nitrate to the aquifer screened by those wells (see figure 5). Concentrations of nitrate in groundwater samples from monitoring well CLA10018 have increased over the last four sampling events after a period of declining concentrations between fall 2017 and spring 2020. Concentrations of nitrate in groundwater samples collected from monitoring well BUT10017 fluctuate from year to year. Nitrate concentrations measured in groundwater samples from monitoring well MIA00205 have been above 3 mg/L for the past seven sampling events suggesting anthropogenic sources of nitrate are impacting the aquifer at that well location.

Trichloroethene (TCE)

Since 2014, concentrations of TCE in groundwater samples from monitoring well BUT10014 have declined (see figure 6). TCE in the fall 2018 sample was below the reporting limit of 1 µg/L and also below the MCL for the first time since sampling began. Groundwater concentrations measured since fall 2018 have remained close to or below the reporting limit.

Figure 3 – Chloride concentrations in monitoring wells

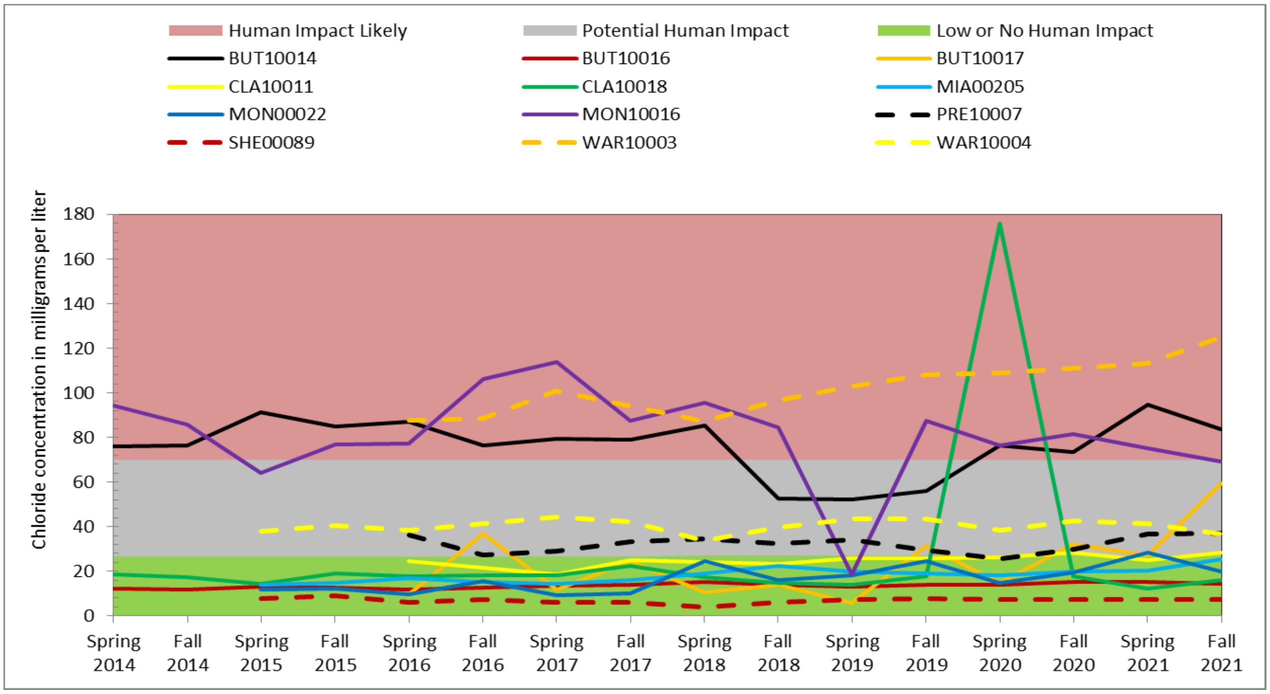


Figure 4 – Sodium concentrations in monitoring wells

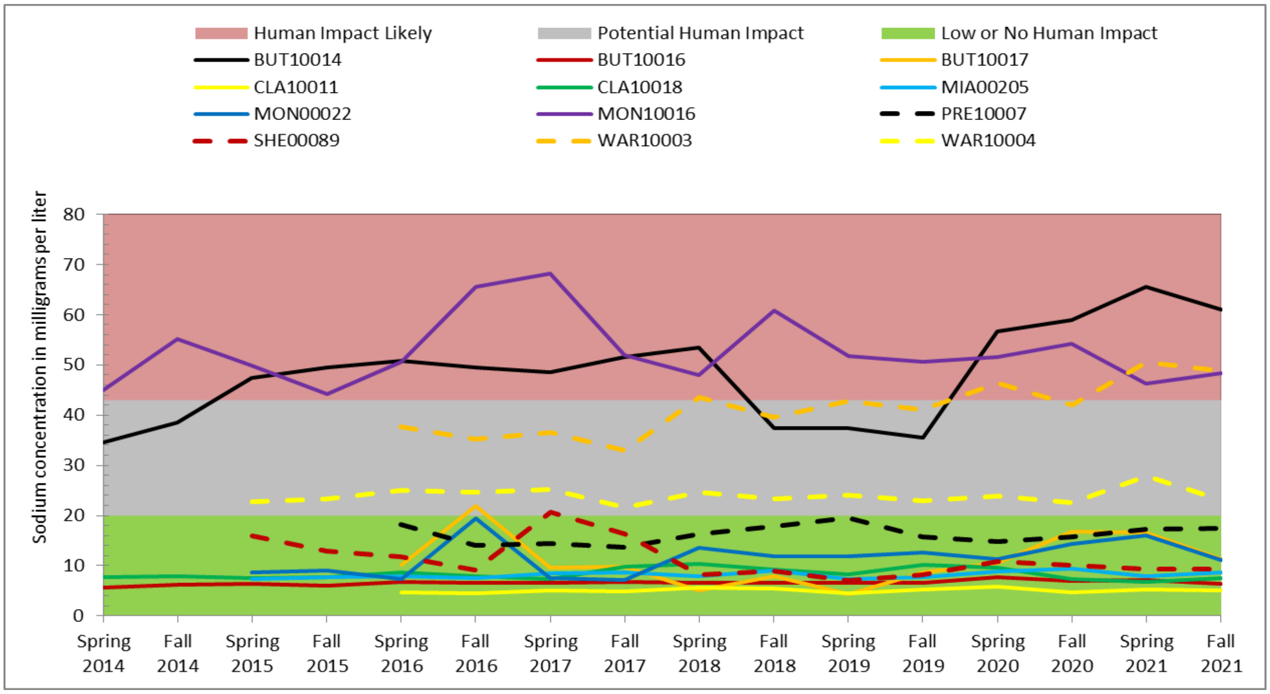


Figure 5 – Nitrate concentrations in monitoring wells

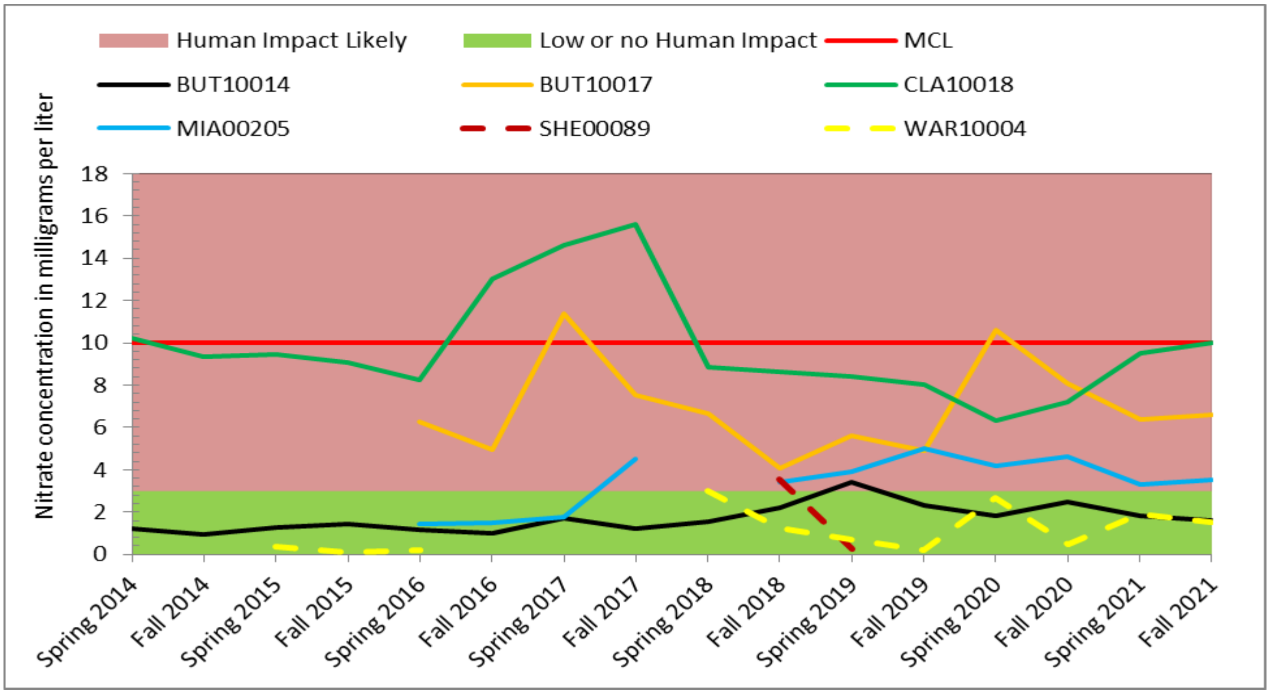
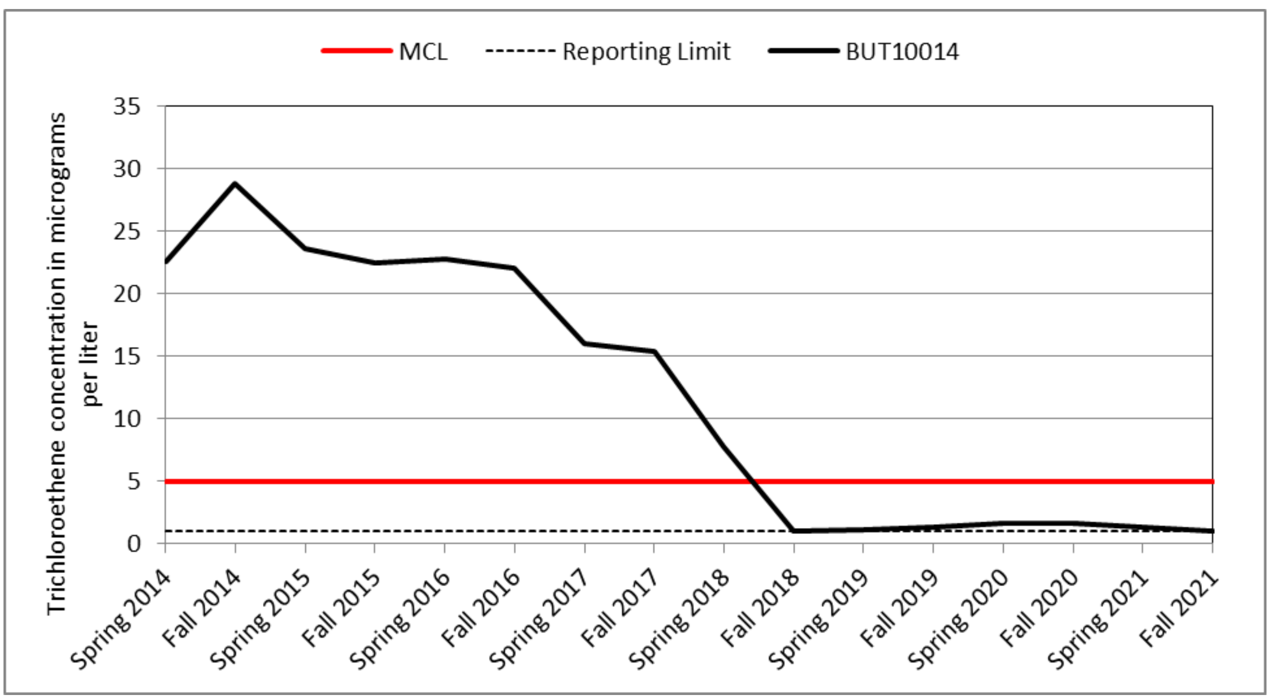


Figure 6 – TCE concentrations in monitoring well BUT10014



Naturally Occurring Contaminants

Arsenic

Arsenic was detected in groundwater samples collected from monitoring wells BUT10016, CLA10011, and PRE10007 (see figure 7). The arsenic concentration (26.8 µg/L) measured during the spring sampling event from monitoring well PRE10007 exceeded the drinking water MCL of 10 µg/L. The arsenic concentration in the fall groundwater sample from PRE10007 fell sharply to 5.9 µg/L. Over all, arsenic concentrations in samples collected from PRE10007 seem to be showing significant fluctuations from sampling event to sampling event and may reflect mixing of groundwater from different aquifer zones. Arsenic concentrations measured in monitoring wells BUT10016 and CLA10011 fluctuate between 4 and 9 µg/L but show no overall upward or downward trend.

Iron

There are large fluctuations in iron concentrations measured in groundwater samples collected from monitoring well PRE10007. These large fluctuations in arsenic and iron concentrations may indicate mixing of oxic and anoxic groundwater in the vicinity of the well. MCD staff noted fluctuating dissolved oxygen levels in the well during recent sampling events as nearby production wells turned on and off. This suggests fluctuating redox conditions at the well. There does not appear to be any upward or downward trend in iron concentrations in the other monitoring wells.

Concentrations of dissolved iron greater than 0.1 mg/L in groundwater are often associated with the presence of arsenic in the glacial aquifer system of the northern United States (Thomas, 2007). When compared with previous studies, iron concentrations in groundwater samples collected from monitoring wells BUT10016, CLA10011, MON10016, PRE10007, and WAR10003 consistently exceed the drinking water SMCL of 0.3 mg/L (see figure 8). Groundwater samples from all five of those monitoring wells consistently have detectable concentrations of arsenic.

Lithium

Lithium is consistently detected at concentrations above the reporting limit in groundwater samples collected from monitoring wells MON00022 and WAR10003 (see figure 9). Lithium concentrations in MON00022 fluctuate above and below the HBSL of 10 µg/L but do not show any upward or downward trend. Concentrations of lithium in WAR10003 have been fairly consistent from sampling event to sampling event and tend to range between 5 and 7 µg/L.

Manganese

Manganese concentrations in groundwater samples collected from monitoring wells BUT10016, CLA10011, MIA00205, MON10016, SHE00089, and WAR10003 consistently exceed the SMCL of 0.05 mg/L (see figure 10). Manganese concentrations measured in groundwater samples from monitoring well BUT10016 were the highest of all the monitoring wells in 2021 as well as in previous sampling events consistently exceeding the HBSL of 0.3 mg/L. There does not appear to be a strong upward or downward trend in manganese concentration for any of the monitoring wells. Manganese concentrations appear to be fairly consistent from sampling event to sampling event.

Figure 7 – Arsenic concentrations in monitoring wells

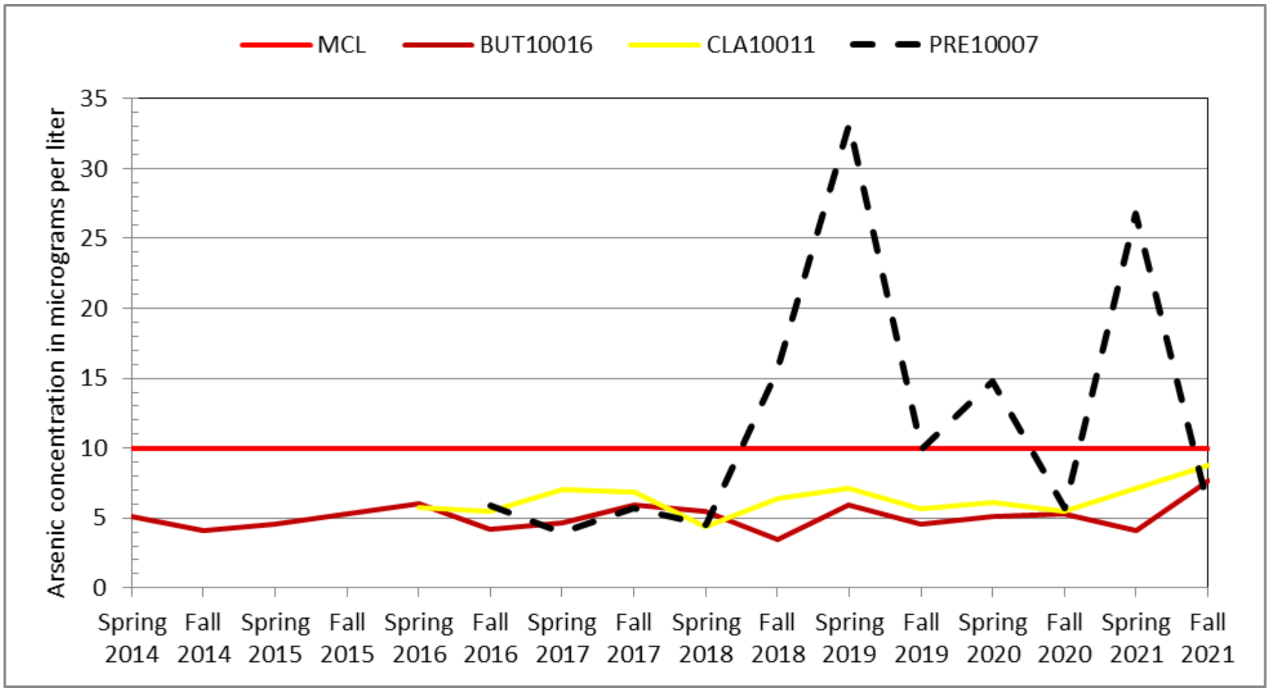


Figure 8 – Iron concentrations in monitoring wells

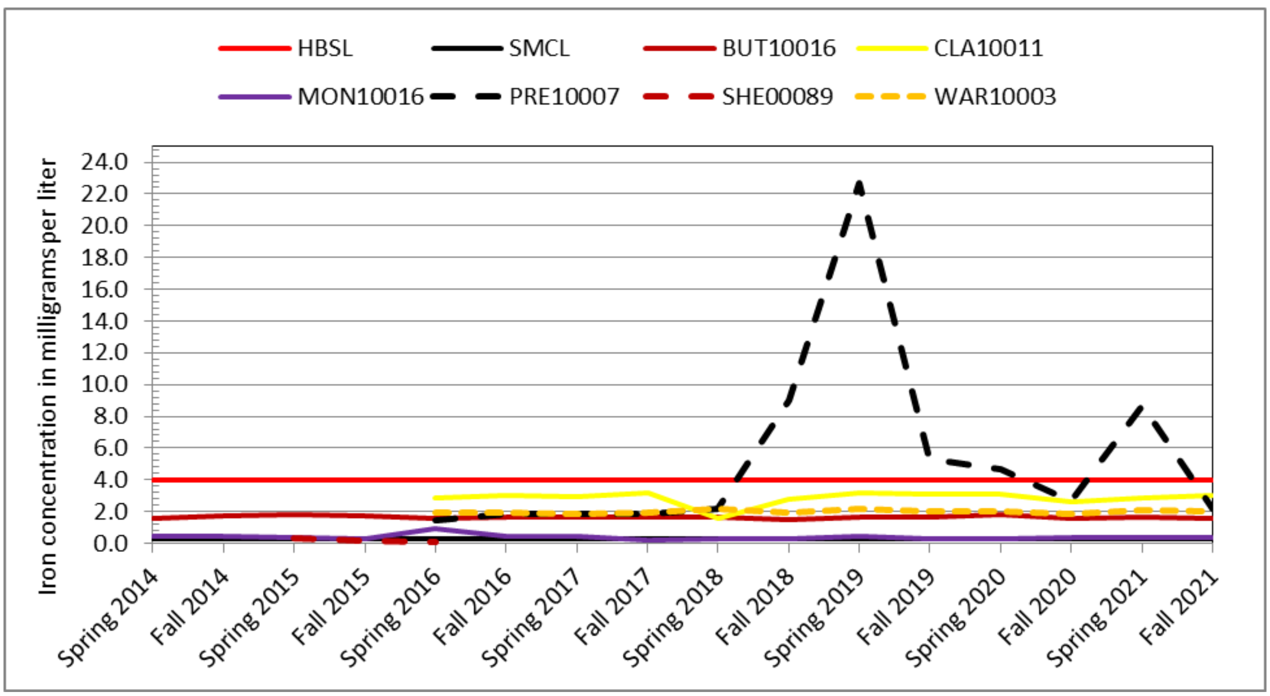


Figure 9 – Lithium concentrations in monitoring wells

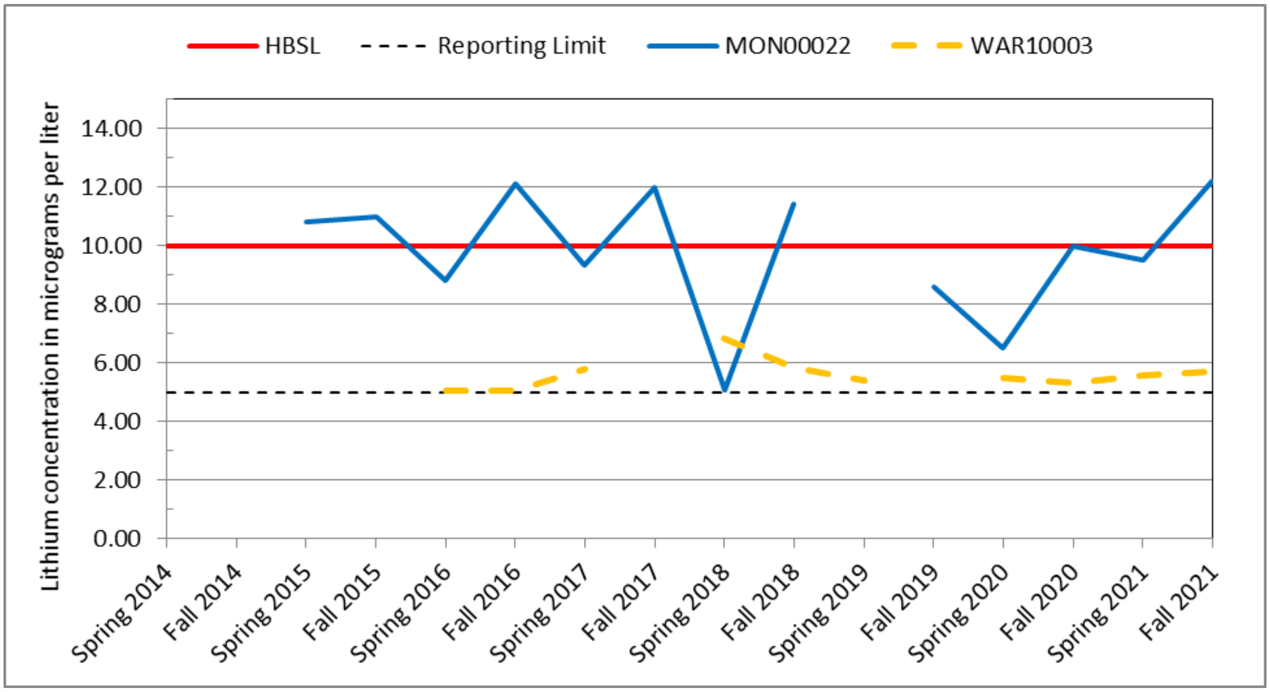
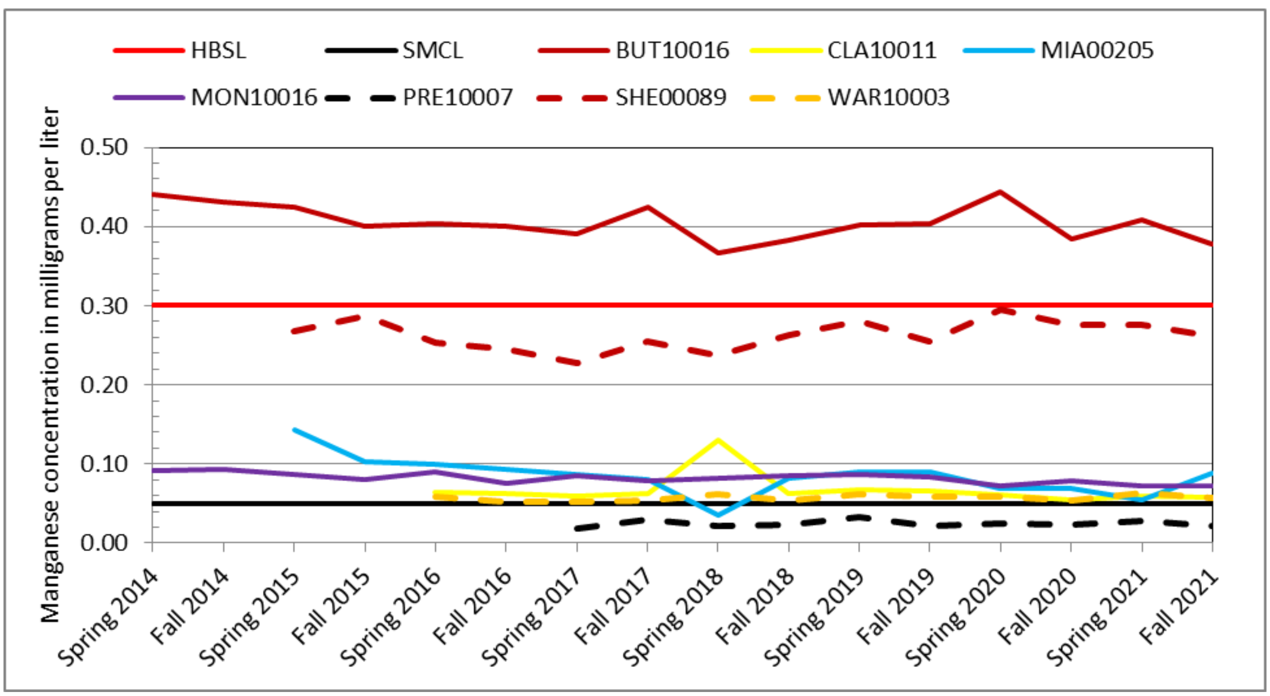


Figure 10 – Manganese concentrations in monitoring wells



Conclusions for 2021

The sample set of the groundwater monitoring program is insufficient in size and scope to characterize in detail the health of the entire buried valley aquifer system. Yet, the results can be used to better understand which contaminants are likely to impact groundwater quality in the buried valley aquifer in southwest Ohio. Furthermore, when the 2021 results are compared with previous rounds of sampling and other studies, some themes related to groundwater quality in the aquifer begin to emerge.

Contaminants originating from anthropogenic sources such as chloride, nitrate, sodium, and VOCs are sometimes present in groundwater samples from sensitive aquifer settings such as shallow unconfined sand and gravel aquifers. This conclusion is supported by other studies which collected groundwater samples from shallow zones in the buried valley aquifer and found similar results (Ohio Environmental Protection Agency, 2015), (Rowe et al, 2004), and (Stuck, 2019a and 2019b).

Naturally occurring contaminants including arsenic and nuisance contaminants are also commonly present in groundwater samples collected from the buried valley aquifer system. Arsenic is a naturally occurring contaminant and may be present in groundwater at concentrations exceeding the MCL. Nuisance contaminants such as hardness, iron, manganese, and total dissolved solids are often present in groundwater at concentrations exceeding secondary drinking water standards and in some cases health-based screening levels. Water softening as well as iron and manganese removal may be necessary to deliver the desired water quality.

These findings emphasize the importance of managing land use over the buried valley aquifer to preserve the quality of the water. They also highlight the interconnected nature of the Great Miami River and the underlying buried valley aquifer system. Anthropogenic constituents present in rivers and streams can also be found in buried valley aquifers. Proactive groundwater protection strategies are critical to ensure the quality of groundwater in our region.

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Appendix A

Spring 2021					Benchmark		Sample Sites			Sample Sites		
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Dissolved Oxygen	mg/L	Field Measured	—	—	—	—	4.50	0.14	9.35	0.16	6.66	0.14
pH	S.U.	Field Measured	—	—	SMCL	6.5 - 8.5	6.97	7.48	7.22	7.18	7.22	7.23
Specific Conductance	mS/cm	Field Measured	—	—	—	—	789	462	690	587	658	498
Temperature	°C	Field Measured	—	—	—	—	13.73	13.22	13.44	12.23	11.60	10.97
Chloride	mg/L	SM 4500-Cl E-11	2.0	0.22	SMCL	250	**94.5**	15.2	26.9	24.8	12.1	20.1
Fluoride	mg/L	SM 4500-F C-11	0.20	0.068	MCL	4	0.20	0.24	< 0.20	0.24	0.30	< 0.20
Nitrogen, Ammonia	mg/L	EPA 350.1	0.10	0.048	—	—	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nitrogen, Kjeldahl, Total	mg/L	SM 4500-Norg D-11	0.50	0.05	—	—	< 0.50	0.83	0.85	16.0	12.7	0.78
Nitrogen, Nitrite	mg/L	SM 4500-NO3 F-11	0.10	0.027	MCL	1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nitrogen, Nitrate	mg/L	SM 4500-NO3 F-11	0.10	0.05	MCL	10	1.8	< 0.10	**6.4**	< 0.10	**9.5**	**3.3**
Orthophosphate as P	mg/L	SM 4500-P F	0.10	0.0085	—	—	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phosphorus, Total	ug/L	EPA 6010B	100	33.8	—	—	< 100	113	< 100	< 100	< 100	< 100
Silica, Total	ug/L	EPA 6010B	100	64.6	—	—	11,000	13,700	10,300	8,520	8,390	3,990
Sulfate	mg/L	SM 4500-SO4 D	5.0	1	SMCL	250	38.5	51.0	20.0	70.2	10.7	28.6
Total Hardness by 2340B	ug/L	EPA 6010B	2000	460	—	—	399,000	306,000	330,000	402,000	318,000	
Aluminum, Total	ug/L	EPA 6010B	100	25.9	HBSL, SMCL	6000, 200	**2,670**	< 100	< 100	< 100	< 100	< 100
Antimony, Total	ug/L	EPA 6020A	0.50	0.47	MCL	6	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0.67
Arsenic, Total	ug/L	EPA 6020A	2.0	0.57	MCL	10	< 2.0	4.1	< 2.0	7.1	< 2.0	< 2.0
Barium, Total	ug/L	EPA 6010B	5.0	2.7	MCL	2000	219	227	47.5	55.8	65.5	102
Beryllium, Total	ug/L	EPA 6010B	0.50	0.18	MCL	4	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Boron, Total	ug/L	EPA 6010B	200	139	HBSL	5000	< 200	< 200	< 200	< 200	< 200	< 200
Cadmium, Total	ug/L	EPA 6020A	1.0	0.62	MCL	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Calcium, Total	ug/L	EPA 6010B	500	429	—	—	109,000	78,200	88,600	101,000	73,300	90,000
Chromium, Hexavalent	mg/L	SM 3500-Cr	0.004	0.0025	HBSL	0.02	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Cobalt, Total	ug/L	EPA 6010B	5.0	1.7	HBSL	2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Copper, Total	ug/L	EPA 6010B	5.0	4.6	MCL	1300	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Iron, Total	ug/L	EPA 6010B	100	79.3	HBSL, SMCL	4000, 300	< 100	**1,640**	< 100	**2,880**	< 100	< 100
Lead, Total	ug/L	EPA 6020A	0.50	0.4	MCL	15	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0.61
Lithium, Total	ug/L	EPA 200.7	5.0	0.5	HBSL	10	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Magnesium, Total	ug/L	EPA 6010B	100	30.4	—	—	30,800	26,900	26,300	36,200	30,300	24,400
Manganese, Total	ug/L	EPA 6010B	5.0	2.8	HBSL, SMCL	300, 50	< 0.50	**408**	< 0.50	**59.8**	< 0.50	**55.1**
Molybdenum, Total	ug/L	EPA 6010B	10.0	4.5	HBSL	30	< 10.0	12	< 10.0	11.3	< 10.0	< 10.0
Nickel, Total	ug/L	EPA 6010B	5.0	4.8	HBSL	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Potassium, Total	ug/L	EPA 6010B	1000	149	—	—	4,630	1,290	2,900	< 1000	1,850	1,070
Silver, Total	ug/L	EPA 6010B	2.0	0.68	HBSL	100	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Sodium, Total	ug/L	EPA 6010B	2000	1460	—	—	**65,600**	7,180	16,600	5,260	6,860	7,950
Strontium, Total	ug/L	EPA 6010B	5.0	0.77	HBSL	4000	681	435	175	314	1,880	332
Thallium, Total	ug/L	EPA 6020A	0.50	0.22	MCL	2	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Vanadium, Total	ug/L	EPA 6010B	5.0	0.85	—	—	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Zinc, Total	ug/L	EPA 6010B	15.0	12	HBSL	2000	228	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0
Alkalinity, Total as CaCO3	mg/L	SM 2320B	5.0	5	—	—	336	298	231	294	134	277
BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbonaceous BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Chemical Oxygen Demand	mg/L	HACH 8000	20.0	7.1	—	—	< 20.0	< 20.0	23.4	< 20.0	< 20.0	< 20.0
Cyanide	mg/L	EPA 335.4	0.01	0.0049	MCL	0.2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phenolics, Total Recoverable	ug/L	EPA 420.4	2.0	1	—	—	2.3	< 2.0	< 2.0	< 2.0	< 2.0	2.1
Total Dissolved Solids	mg/L	SM 2540C	10.0	10	SMCL	500	**532**	320	366	464	388	382
Total Organic Carbon	mg/L	SM 5310C-11	1.0	0.36	—	—	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
E.coli	MPN/100mL	SM 9223B	1.0	1	MCL	0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0

Appendix A

Spring 2021					Benchmark		Sample Sites			Sample Sites		
Parameter	Units	Method	PQL	MDL	Type	Value	BUT10014	BUT10016	BUT10017	CLA10011	CLA10018	MIA00205
1,1,1,2-Tetrachloroethane	ug/L	SW 8260B	1.0	0.22	HBSL	0.2	< 1.0					
1,1,1-Trichloroethane	ug/L	SW 8260B	1.0	0.28	MCL	200	< 1.0					
1,1,2,2-Tetrachloroethane	ug/L	SW 8260B	1.0	0.23	HBSL	0.0002	< 1.0					
1,1,2-Trichloroethane	ug/L	SW 8260B	1.0	0.34	MCL	5	< 1.0					
1,1-Dichloroethane	ug/L	SW 8260B	1.0	0.27	HBSL	1000	< 1.0					
1,1-Dichloroethene	ug/L	SW 8260B	1.0	0.22	MCL	7	< 1.0					
1,1-Dichloropropene	ug/L	SW 8260B	1.0	0.21	—	—	< 1.0					
1,2,3-Trichlorobenzene	ug/L	SW 8260B	1.0	0.23	—	—	< 1.0					
1,2,3-Trichloropropane	ug/L	SW 8260B	1.0	0.27	HBSL	30	< 1.0					
1,2,4-Trichlorobenzene	ug/L	SW 8260B	1.0	0.21	MCL	70	< 1.0					
1,2-Dibromo-3-chloropropane	ug/L	SW 8260B	5.0	0.87	MCL	0.2	< 5.0					
1,2-Dibromoethane (EDB)	ug/L	SW 8260B	1.0	0.19	MCL	0.05	< 1.0					
1,2-Dichlorobenzene	ug/L	SW 8260B	1.0	0.57	MCL	600	< 1.0					
1,2-Dichloroethane	ug/L	SW 8260B	1.0	0.3	MCL	5	< 1.0					
1,2-Dichloropropane	ug/L	SW 8260B	1.0	0.23	MCL	5	< 1.0					
1,3-Dichlorobenzene	ug/L	SW 8260B	1.0	0.2	HBSL	600	< 1.0					
1,3-Dichloropropane	ug/L	SW 8260B	1.0	0.24	HBSL	100	< 1.0					
1,4-Dichlorobenzene	ug/L	SW 8260B	1.0	0.21	MCL	75	< 1.0					
2,2-Dichloropropane	ug/L	SW 8260B	1.0	0.26	—	—	< 1.0					
2-Butanone (MEK)	ug/L	SW 8260B	10.0	2.7	—	—	< 10					
2-Chlorotoluene	ug/L	SW 8260B	1.0	0.22	—	—	< 1.0					
2-Hexanone	ug/L	SW 8260B	10.0	0.078	HBSL	30	< 10					
4-Chlorotoluene	ug/L	SW 8260B	1.0	0.24	HBSL	100	< 1.0					
4-Methyl-2-pentanone (MIBK)	ug/L	SW 8260B	10.0	1.9	—	—	< 10.0					
Acetone	ug/L	SW 8260B	10.0	3.8	HBSL	6000	< 10.0					
Acetonitrile	ug/L	SW 8260B	10.0	2.4	—	—	< 10.0					
Benzene	ug/L	SW 8260B	1.0	0.27	MCL	5	< 1.0					
Bromobenzene	ug/L	SW 8260B	1.0	0.22	HBSL	50	< 1.0					
Bromochloromethane	ug/L	SW 8260B	1.0	0.29	HBSL	60	< 1.0					
Bromodichloromethane	ug/L	SW 8260B	1.0	0.23	MCL	80	< 1.0					
Bromoform	ug/L	SW 8260B	1.0	0.23	MCL	80	< 1.0					
Bromomethane	ug/L	SW 8260B	1.0	0.29	HHBP	140	< 1.0					
Carbon disulfide	ug/L	SW 8260B	1.0	0.24	HBSL	600	< 1.0					
Carbon tetrachloride	ug/L	SW 8260B	1.0	0.24	MCL	5	< 1.0					
Chlorobenzene	ug/L	SW 8260B	1.0	0.26	MCL	100	< 1.0					
Chloroethane	ug/L	SW 8260B	1.0	0.26	—	—	< 1.0					
Chloroform	ug/L	SW 8260B	1.0	0.27	MCL	80	< 1.0					
Chloromethane	ug/L	SW 8260B	1.0	0.32	—	—	< 1.0					
cis-1,2-Dichloroethene	ug/L	SW 8260B	1.0	0.3	MCL	70	< 1.0					
cis-1,3-Dichloropropene	ug/L	SW 8260B	1.0	0.23	HBSL	0.3	< 1.0					
Dibromochloromethane	ug/L	SW 8260B	1.0	0.65	MCL	80	< 1.0					
Dibromomethane	ug/L	SW 8260B	1.0	0.3	—	—	< 1.0					
Dichlorodifluoromethane	ug/L	SW 8260B	1.0	0.24	HBSL	1000	< 1.0					
Ethyl acetate	ug/L	SW 8260B	1.0	0.21	HBSL	6000	< 1.0					
Ethylbenzene	ug/L	SW 8260B	1.0	0.17	MCL	700	< 1.0					
Hexachloro-1,3-butadiene	ug/L	SW 8260B	1.0	0.28	—	—	< 1.0					
m&p-Xylene	ug/L	SW 8260B	1.0	0.41	MCL	10000	< 1.0					
Methylene Chloride	ug/L	SW 8260B	1.0	0.16	MCL	5	< 1.0					
Methyl-tert-butyl ether	ug/L	SW 8260B	1.0	0.24	—	—	< 1.0					

Appendix A

Spring 2021					Benchmark		Sample Sites			Sample Sites		
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Naphthalene	ug/L	SW 8260B	1.0	0.21	HBSL	100	< 1.0					
o-Xylene	ug/L	SW 8260B	1.0	0.22	MCL	10000	< 1.0					
p-Isopropyltoluene	ug/L	SW 8260B	1.0	0.18	—	—	< 1.0					
Styrene	ug/L	SW 8260B	1.0	0.21	MCL	100	< 1.0					
Tetrachloroethene	ug/L	SW 8260B	1.0	0.23	MCL	5	< 1.0					
Toluene	ug/L	SW 8260B	1.0	0.23	MCL	1000	< 1.0					
trans-1,2-Dichloroethene	ug/L	SW 8260B	1.0	0.22	MCL	100	< 1.0					
trans-1,3-Dichloropropene	ug/L	SW 8260B	1.0	0.2	HBSL	0.3	< 1.0					
Trichloroethene	ug/L	SW 8260B	1.0	0.3	MCL	5	**1.3**					
Trichlorofluoromethane	ug/L	SW 8260B	1.0	0.25	HBSL	2000	< 1.0					
Vinyl acetate	ug/L	SW 8260B	5.0	0.28	—	—	< 5.0					
Vinyl chloride	ug/L	SW 8260B	1.0	0.22	MCL	2	< 1.0					
Xylene (Total)	ug/L	SW 8260B	1.0	0.41	MCL	10000	< 1.0					

Appendix A

Spring 2021					**Benchmark**		**Sample Sites**			**Samples Sites**		
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**MON00022**	**MON10016**	**PRE10007**	**SHE00089**	**WAR10003**	**WAR10004**
Dissolved Oxygen	mg/L	Field Measured	—	—	—	—	0.94	0.00	0.01	0.14	0.00	2.81
pH	S.U.	Field Measured	—	—	SMCL	6.5 - 8.5	7.00	7.32	7.28	7.23	7.26	7.39
Specific Conductance	mS/cm	Field Measured	—	—	—	—	803	802	749	516	1,043	613
Temperature	°C	Field Measured	—	—	—	—	11.30	12.00	12.50	12.01	14.00	14.10
Chloride	mg/L	SM 4500-Cl E-11	2.0	0.22	SMCL	250	28.5	**75.1**	36.6	7.2	**113**	41.2
Fluoride	mg/L	SM 4500-F C-11	0.20	0.068	MCL	4	< 0.20	0.20	0.27	0.37	0.23	0.22
Nitrogen, Ammonia	mg/L	EPA 350.1	0.10	0.048	—	—	< 0.10	< 0.10	< 0.10	< 0.10	0.12	< 0.10
Nitrogen, Kjeldahl, Total	mg/L	SM 4500-Norg D-11	0.50	0.05	—	—	2.6	< 0.50	< 0.50	< 0.50	0.81	< 0.50
Nitrogen, Nitrite	mg/L	SM 4500-NO3 F-11	0.10	0.027	MCL	1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nitrogen, Nitrate	mg/L	SM 4500-NO3 F-11	0.10	0.05	MCL	10	0.17	< 0.10	< 0.10	< 0.10	< 0.10	1.9
Orthophosphate as P	mg/L	SM 4500-P F	0.10	0.0085	—	—	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phosphorus, Total	ug/L	EPA 6010B	100	33.8	—	—	< 100	< 100	< 100	< 100	< 100	< 100
Silica, Total	ug/L	EPA 6010B	100	64.6	—	—	7,260	8,940	12,200	10,800	14,000	8,380
Sulfate	mg/L	SM 4500-SO4 D	5.0	1	SMCL	250	203	31.9	50.2	41.8	79.4	26.1
Total Hardness by 2340B	ug/L	EPA 6010B	2000	460	—	—	582,000	294,000	357,000	359,000	430,000	260,000
Aluminum, Total	ug/L	EPA 6010B	100	25.9	HBSL, SMCL	6000, 200	< 100	< 100	< 100	< 100	**602**	**1,240**
Antimony, Total	ug/L	EPA 6020A	0.50	0.47	MCL	6	0.70	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Arsenic, Total	ug/L	EPA 6020A	2.0	0.57	MCL	10	< 2.0	< 2.0	**26.8**	< 2.0	< 2.0	< 2.0
Barium, Total	ug/L	EPA 6010B	5.0	2.7	MCL	2000	99.7	98.4	259	146	208	59.3
Beryllium, Total	ug/L	EPA 6010B	0.50	0.18	MCL	4	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Boron, Total	ug/L	EPA 6010B	200	139	HBSL	5000	< 200	< 200	< 200	< 200	236	< 200
Cadmium, Total	ug/L	EPA 6020A	1.0	0.62	MCL	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Calcium, Total	ug/L	EPA 6010B	500	429	—	—	159,000	77,700	83,300	87,700	104,000	58,500
Chromium, Hexavalent	mg/L	SM 3500-Cr	0.004	0.0025	HBSL	0.02	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Cobalt, Total	ug/L	EPA 6010B	5.0	1.7	HBSL	2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Copper, Total	ug/L	EPA 6010B	5.0	4.6	MCL	1300	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6.6
Iron, Total	ug/L	EPA 6010B	100	79.3	HBSL, SMCL	4000, 300	< 100	**364**	**8,660**	< 100	**2,080**	< 100
Lead, Total	ug/L	EPA 6020A	0.50	0.4	MCL	15	0.67	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Lithium, Total	ug/L	EPA 200.7	5.0	0.5	HBSL	10	9.5	< 0.50	5.4	< 0.50	5.6	< 0.50
Magnesium, Total	ug/L	EPA 6010B	100	30.4	—	—	44,600	24,300	33,200	34,000	41,100	27,600
Manganese, Total	ug/L	EPA 6010B	5.0	2.8	HBSL, SMCL	300, 50	< 0.50	**73**	28.3	**275**	**63**	< 0.50
Molybdenum, Total	ug/L	EPA 6010B	10.0	4.5	HBSL	30	< 10.0	< 10.0	< 10.0	14.1	12.6	10.1
Nickel, Total	ug/L	EPA 6010B	5.0	4.8	HBSL	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Potassium, Total	ug/L	EPA 6010B	1000	149	—	—	3,810	2,860	1,960	1,140	2,890	2,560
Silver, Total	ug/L	EPA 6010B	2.0	0.68	HBSL	100	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Sodium, Total	ug/L	EPA 6010B	2000	1460	—	—	16,100	**46,200**	17,300	9,400	**50,500**	27,800
Strontium, Total	ug/L	EPA 6010B	5.0	0.77	HBSL	4000	485	446	945	530	1,090	429
Thallium, Total	ug/L	EPA 6020A	0.50	0.22	MCL	2	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Vanadium, Total	ug/L	EPA 6010B	5.0	0.85	—	—	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Zinc, Total	ug/L	EPA 6010B	15.0	12	HBSL	2000	< 15.0	< 15.0	< 15.0	< 15.0	138	123
Alkalinity, Total as CaCO3	mg/L	SM 2320B	5.0	5	—	—	370	256	147	302	277	223
BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbonaceous BOD, 5 day	mg/L	SM 5210B	2.0	2	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Chemical Oxygen Demand	mg/L	HACH 8000	20.0	7.1	—	—	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0	< 20.0
Cyanide	mg/L	EPA 335.4	0.01	0.0049	MCL	0.2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phenolics, Total Recoverable	ug/L	EPA 420.4	2.0	1	—	—	2.2	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Total Dissolved Solids	mg/L	SM 2540C	10.0	10	SMCL	500	**742**	452	466	402	**604**	14
Total Organic Carbon	mg/L	SM 5310C-11	1.0	0.36	—	—	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
E.coli	MPN/100mL	SM 9223B	1.0	1	MCL	0	< 1.0	**12.8**	< 1.0	< 1.0	< 1.0	< 1.0

Appendix A

Fall 2021					Benchmark		Sample Sites			Sample Sites		
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Dissolved Oxygen	mg/L	Field Measured	—	—	—	—	3.04	0.07	8.92	0.02	6.25	0.13
pH	S.U.	Field Measured	—	—	SMCL	6.5 - 8.5	7.21	7.52	7.32	7.32	7.25	7.29
Specific Conductance	mS/cm	Field Measured	—	—	—	—	986	599	658	658	668	707
Temperature	°C	Field Measured	—	—	—	—	15.1	12.8	12.3	12.2	16.6	12.4
Oxidation Reduction Potential	mV	Field Measured	—	—	—	—	192.3	-123.4	236.2	-93.9	213.6	131.0
Chloride	mg/L	SM 4500-Cl E-11	2.0	0.22	SMCL	250	**83.6**	14.4	59.6	28.2	16.0	25.5
Fluoride	mg/L	SM 4500-F C-11	0.20	0.068	MCL	4	< 0.20	< 0.20	< 0.20	0.32	0.24	0.20
Nitrogen, Ammonia	mg/L	EPA 350.1	0.10	0.048	—	—	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nitrogen, Kjeldahl, Total	mg/L	SM 4500-Norg D-11	0.50	0.05	—	—	< 0.50	< 0.50	0.86	1.20	3.10	0.83
Nitrogen, Nitrite	mg/L	SM 4500-NO3 F-11	0.10	0.027	MCL	1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nitrogen, Nitrate	mg/L	SM 4500-NO3 F-11	0.10	0.05	MCL	10	1.6	< 0.10	**6.6**	< 0.10	**10**	**3.5**
Orthophosphate as P	mg/L	SM 4500-P F	0.10	0.0085	—	—	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phosphorus, Total	ug/L	EPA 6010B	100	33.8	—	—	< 100	< 100	< 100	< 100	< 100	< 100
Silica, Total	ug/L	EPA 6010B	100	64.6	—	—	10,300	12,900	9,510	15,100	9,600	9,090
Sulfate	mg/L	SM 4500-SO4 D	5.0	1.0	SMCL	250	41.6	52.9	119.0	143.0	19.1	94.9
Total Hardness by 2340B	ug/L	EPA 6010B	2000	460	—	—	344,000	280,000	298,000	392,000	308,000	335,000
Aluminum, Total	ug/L	EPA 6010B	100	25.9	HBSL, SMCL	6000, 200	< 100	< 100	< 100	< 100	< 100	< 100
Antimony, Total	ug/L	EPA 6020A	0.50	0.47	MCL	6	< 0.50	< 0.50	< 0.50	0.71	< 0.50	0.64
Arsenic, Total	ug/L	EPA 6020A	2.0	0.57	MCL	10	< 2.0	7.7	< 2.0	8.8	< 2.0	< 2.0
Barium, Total	ug/L	EPA 6010B	5.0	2.7	MCL	2000	188	205	38.7	52.4	71.9	110
Beryllium, Total	ug/L	EPA 6010B	0.50	0.18	MCL	4	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	1.2
Boron, Total	ug/L	EPA 6010B	200	139	HBSL	5000	< 200	< 200	< 200	< 200	< 200	< 200
Cadmium, Total	ug/L	EPA 6020A	1.0	0.62	MCL	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Calcium, Total	ug/L	EPA 6010B	500	429	—	—	94,400	71,600	80,400	98,400	73,500	92,400
Chromium, Hexavalent	mg/L	SM 3500-Cr	0.004	0.0025	HBSL	0.02	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Cobalt, Total	ug/L	EPA 6010B	5.0	1.7	HBSL	2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Copper, Total	ug/L	EPA 6010B	5.0	4.6	MCL	1300	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Iron, Total	ug/L	EPA 6010B	100	79.3	HBSL, SMCL	4000, 300	< 100	**1,560**	< 100	**2,990**	< 100	< 100
Lead, Total	ug/L	EPA 6020A	0.50	0.40	MCL	15	< 0.50	< 0.50	< 0.50	0.55	< 0.50	0.61
Lithium, Total	ug/L	EPA 200.7	5.0	0.5	HBSL	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Magnesium, Total	ug/L	EPA 6010B	100	30.4	—	—	26,300	26,900	23,500	35,400	30,100	25,300
Manganese, Total	ug/L	EPA 6010B	5.0	2.8	HBSL, SMCL	300, 50	< 5.0	**378**	< 5.0	**58.6**	< 5.0	**89.1**
Molybdenum, Total	ug/L	EPA 6010B	10.0	4.5	HBSL	30	< 10.0	12.0	< 10.0	< 10.0	< 10.0	11.7
Nickel, Total	ug/L	EPA 6010B	5.0	4.8	HBSL	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5.5
Potassium, Total	ug/L	EPA 6010B	1000	149	—	—	3,890	1,290	2,140	< 1000	2,080	1,040
Silver, Total	ug/L	EPA 6010B	2.0	0.68	HBSL	100	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Sodium, Total	ug/L	EPA 6010B	2000	1460	—	—	**61,000**	6,420	11,300	5,110	7,600	8,600
Strontium, Total	ug/L	EPA 6010B	5.0	0.77	HBSL	4000	586	393	153	306	2,040	342
Thallium, Total	ug/L	EPA 6020A	0.50	0.22	MCL	2	< 0.50	< 0.50	< 0.50	0.60	< 0.50	< 0.50
Vanadium, Total	ug/L	EPA 6010B	5.0	0.85	—	—	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Zinc, Total	ug/L	EPA 6010B	15.0	12.0	HBSL	2000	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0
Alkalinity, Total as CaCO3	mg/L	SM 2320B	5.0	5.0	—	—	356	250	307	144	152	242
BOD, 5 day	mg/L	SM 5210B	2.0	2.0	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbonaceous BOD, 5 day	mg/L	SM 5210B	2.0	2.0	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Chemical Oxygen Demand	mg/L	HACH 8000	20.0	7.1	—	—	< 20.0	< 20.0	23.4	< 20.0	< 20.0	< 20.0
Cyanide	mg/L	EPA 335.4	0.01	0.0049	MCL	0.2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phenolics, Total Recoverable	ug/L	EPA 420.4	2.0	1.0	—	—	< 2.0	< 2.0	< 2.0	3.1	2.1	< 2.0
Total Dissolved Solids	mg/L	SM 2540C	10.0	10.0	SMCL	500	**526**	272	346	470	108	400
Total Organic Carbon	mg/L	SM 5310C-11	1.0	0.36	—	—	< 1.0	< 1.0	< 1.0	1.1	< 1.0	< 1.0
E.coli	MPN/100mL	SM 9223B	1.0	1.0	MCL	0	< 1.0	< 1.0	< 1.0	< 1.0	< 5.0	< 1.0

Appendix A

Fall 2021					Benchmark		Sample Sites			Sample Sites		
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
1,1,1,2-Tetrachloroethane	ug/L	SW 8260B	1.0	0.22	HBSL	0.2	< 1.0					
1,1,1-Trichloroethane	ug/L	SW 8260B	1.0	0.28	MCL	200	< 1.0					
1,1,2,2-Tetrachloroethane	ug/L	SW 8260B	1.0	0.23	HBSL	0.0002	< 1.0					
1,1,2-Trichloroethane	ug/L	SW 8260B	1.0	0.34	MCL	5	< 1.0					
1,1-Dichloroethane	ug/L	SW 8260B	1.0	0.27	HBSL	1000	< 1.0					
1,1-Dichloroethene	ug/L	SW 8260B	1.0	0.22	MCL	7	< 1.0					
1,1-Dichloropropene	ug/L	SW 8260B	1.0	0.21	—	—	< 1.0					
1,2,3-Trichlorobenzene	ug/L	SW 8260B	1.0	0.23	—	—	< 1.0					
1,2,3-Trichloropropane	ug/L	SW 8260B	1.0	0.27	HBSL	30	< 1.0					
1,2,4-Trichlorobenzene	ug/L	SW 8260B	1.0	0.21	MCL	70	< 1.0					
1,2-Dibromo-3-chloropropane	ug/L	SW 8260B	5.0	0.87	MCL	0.2	< 5.0					
1,2-Dibromoethane (EDB)	ug/L	SW 8260B	1.0	0.19	MCL	0.05	< 1.0					
1,2-Dichlorobenzene	ug/L	SW 8260B	1.0	0.57	MCL	600	< 1.0					
1,2-Dichloroethane	ug/L	SW 8260B	1.0	0.30	MCL	5	< 1.0					
1,2-Dichloropropane	ug/L	SW 8260B	1.0	0.23	MCL	5	< 1.0					
1,3-Dichlorobenzene	ug/L	SW 8260B	1.0	0.2	HBSL	600	< 1.0					
1,3-Dichloropropane	ug/L	SW 8260B	1.0	0.24	HBSL	100	< 1.0					
1,4-Dichlorobenzene	ug/L	SW 8260B	1.0	0.21	MCL	75	< 1.0					
2,2-Dichloropropane	ug/L	SW 8260B	1.0	0.26	—	—	< 1.0					
2-Butanone (MEK)	ug/L	SW 8260B	10.0	2.7	—	—	< 10.0					
2-Chlorotoluene	ug/L	SW 8260B	1.0	0.22	—	—	< 1.0					
2-Hexanone	ug/L	SW 8260B	10.0	0.078	HBSL	30	< 10.0					
4-Chlorotoluene	ug/L	SW 8260B	1.0	0.24	HBSL	100	< 1.0					
4-Methyl-2-pentanone (MIBK)	ug/L	SW 8260B	10.0	1.9	—	—	< 10.0					
Acetone	ug/L	SW 8260B	10.0	3.8	HBSL	6000	< 10.0					
Acetonitrile	ug/L	SW 8260B	10.0	2.4	—	—	< 10.0					
Benzene	ug/L	SW 8260B	1.0	0.27	MCL	5	< 1.0					
Bromobenzene	ug/L	SW 8260B	1.0	0.22	HBSL	50	< 1.0					
Bromochloromethane	ug/L	SW 8260B	1.0	0.29	HBSL	60	< 1.0					
Bromodichloromethane	ug/L	SW 8260B	1.0	0.23	MCL	80	< 1.0					
Bromoform	ug/L	SW 8260B	1.0	0.23	MCL	80	< 1.0					
Bromomethane	ug/L	SW 8260B	1.0	0.29	HHBP	140	< 1.0					
Carbon disulfide	ug/L	SW 8260B	1.0	0.24	HBSL	600	< 1.0					
Carbon tetrachloride	ug/L	SW 8260B	1.0	0.24	MCL	5	< 1.0					
Chlorobenzene	ug/L	SW 8260B	1.0	0.26	MCL	100	< 1.0					
Chloroethane	ug/L	SW 8260B	1.0	0.26	—	—	< 1.0					
Chloroform	ug/L	SW 8260B	1.0	0.27	MCL	80	< 1.0					
Chloromethane	ug/L	SW 8260B	1.0	0.32	—	—	< 1.0					
cis-1,2-Dichloroethene	ug/L	SW 8260B	1.0	0.3	MCL	70	< 1.0					
cis-1,3-Dichloropropene	ug/L	SW 8260B	1.0	0.23	HBSL	0.3	< 1.0					
Dibromochloromethane	ug/L	SW 8260B	1.0	0.65	MCL	80	< 1.0					
Dibromomethane	ug/L	SW 8260B	1.0	0.30	—	—	< 1.0					
Dichlorodifluoromethane	ug/L	SW 8260B	1.0	0.24	HBSL	1000	< 1.0					
Ethyl acetate	ug/L	SW 8260B	1.0	0.21	HBSL	6000	< 1.0					
Ethylbenzene	ug/L	SW 8260B	1.0	0.17	MCL	700	< 1.0					
Hexachloro-1,3-butadiene	ug/L	SW 8260B	1.0	0.28	—	—	< 1.0					
m&p-Xylene	ug/L	SW 8260B	1.0	0.41	MCL	10000	< 1.0					
Methylene Chloride	ug/L	SW 8260B	1.0	0.16	MCL	5	< 1.0					
Methyl-tert-butyl ether	ug/L	SW 8260B	1.0	0.24	—	—	< 1.0					

Appendix A

Fall 2021					Benchmark		Sample Sites			Sample Sites		
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**BUT10014**	**BUT10016**	**BUT10017**	**CLA10011**	**CLA10018**	**MIA00205**
Naphthalene	ug/L	SW 8260B	1.0	0.21	HBSL	100	< 1.0					
o-Xylene	ug/L	SW 8260B	1.0	0.22	MCL	10000	< 1.0					
p-Isopropyltoluene	ug/L	SW 8260B	1.0	0.18	—	—	< 1.0					
Styrene	ug/L	SW 8260B	1.0	0.21	MCL	100	< 1.0					
Tetrachloroethene	ug/L	SW 8260B	1.0	0.23	MCL	5	< 1.0					
Toluene	ug/L	SW 8260B	1.0	0.23	MCL	1000	< 1.0					
trans-1,2-Dichloroethene	ug/L	SW 8260B	1.0	0.22	MCL	100	< 1.0					
trans-1,3-Dichloropropene	ug/L	SW 8260B	1.0	0.20	HBSL	0.3	< 1.0					
Trichloroethene	ug/L	SW 8260B	1.0	0.30	MCL	5	< 1.0					
Trichlorofluoromethane	ug/L	SW 8260B	1.0	0.25	HBSL	2000	< 1.0					
Vinyl acetate	ug/L	SW 8260B	5.0	0.28	—	—	< 5.0					
Vinyl chloride	ug/L	SW 8260B	1.0	0.22	MCL	2	< 1.0					
Xylene (Total)	ug/L	SW 8260B	1.0	0.41	MCL	10000	< 1.0					

Appendix A

Fall 2021					Benchmark		Sample Sites			Sample Sites		
Parameter	**Units**	**Method**	**PQL**	**MDL**	**Type**	**Value**	**MON00022**	**MON10016**	**PRE10007**	**SHE00089**	**WAR10003**	**WAR10004**
Dissolved Oxygen	mg/L	Field Measured	—	—	—	—	0.13	0.03	0.06	0.04	0.02	1.42
pH	S.U.	Field Measured	—	—	SMCL	6.5 - 8.5	6.98	7.43	7.39	7.30	7.42	7.56
Specific Conductance	mS/cm	Field Measured	—	—	—	—	1,076	802	761	695	1,053	586
Temperature	°C	Field Measured	—	—	—	—	16.6	12.1	12.7	11.6	14.4	14.7
Oxidation Reduction Potential	mV	Field Measured	—	—	—	—	65.2	-66.9	-104.3	82.7	-117.3	170.1
Chloride	mg/L	SM 4500-Cl E-11	2.0	0.22	SMCL	250	19.8	**69.2**	37.1	7.3	**125.0**	36.8
Fluoride	mg/L	SM 4500-F C-11	0.20	0.068	MCL	4	< 0.20	< 0.20	< 0.20	0.42	0.21	0.23
Nitrogen, Ammonia	mg/L	EPA 350.1	0.10	0.048	—	—	< 0.10	< 0.10	< 0.10	< 0.10	0.18	< 0.1
Nitrogen, Kjeldahl, Total	mg/L	SM 4500-Norg D-11	0.50	0.05	—	—	< 0.50	< 0.50	< 0.50	3.60	0.81	< 0.50
Nitrogen, Nitrite	mg/L	SM 4500-NO3 F-11	0.10	0.027	MCL	1	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nitrogen, Nitrate	mg/L	SM 4500-NO3 F-11	0.10	0.05	MCL	10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	1.5
Orthophosphate as P	mg/L	SM 4500-P F	0.10	0.0085	—	—	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phosphorus, Total	ug/L	EPA 6010B	100	33.8	—	—	< 100	< 100	< 100	< 100	< 100	< 100
Silica, Total	ug/L	EPA 6010B	100	64.6	—	—	8,850	9,290	11,700	10,700	13,400	7,990
Sulfate	mg/L	SM 4500-SO4 D	5.0	1.0	SMCL	250	185.0	51.7	54.3	102.0	57.0	26.8
Total Hardness by 2340B	ug/L	EPA 6010B	2000	460	—	—	540,000	305,000	358,000	346,000	401,000	241,000
Aluminum, Total	ug/L	EPA 6010B	100	25.9	HBSL, SMCL	6000, 200	< 100	< 100	< 100	< 100	< 100	< 100
Antimony, Total	ug/L	EPA 6020A	0.50	0.47	MCL	6	< 0.50	0.62	< 0.50	< 0.50	< 0.50	0.72
Arsenic, Total	ug/L	EPA 6020A	2.0	0.57	MCL	10	< 2.0	< 2.0	5.9	< 2.0	2.8	< 2.0
Barium, Total	ug/L	EPA 6010B	5.0	2.7	MCL	2000	108	99.4	222	135	191	55.5
Beryllium, Total	ug/L	EPA 6010B	0.50	0.18	MCL	4	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Boron, Total	ug/L	EPA 6010B	200	139	HBSL	5000	< 200	< 200	< 200	< 200	211	< 200
Cadmium, Total	ug/L	EPA 6020A	1.0	0.62	MCL	5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Calcium, Total	ug/L	EPA 6010B	500	429	—	—	148,000	80,200	86,900	84,500	98,300	54,300
Chromium, Hexavalent	mg/L	SM 3500-Cr	0.004	0.0025	HBSL	0.02	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Cobalt, Total	ug/L	EPA 6010B	5.0	1.7	HBSL	2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Copper, Total	ug/L	EPA 6010B	5.0	4.6	MCL	1300	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	6.6
Iron, Total	ug/L	EPA 6010B	100	79.3	HBSL, SMCL	4000, 300	< 100	**326**	**2,160**	< 100	**1,980**	< 100
Lead, Total	ug/L	EPA 6020A	0.50	0.40	MCL	15	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	0.52
Lithium, Total	ug/L	EPA 200.7	5.0	0.5	HBSL	10	**12.2**	< 5.0	< 5.0	< 5.0	5.7	< 5.0
Magnesium, Total	ug/L	EPA 6010B	100	30.4	—	—	41,200	25,300	34,300	32,800	37,800	25,500
Manganese, Total	ug/L	EPA 6010B	5.0	2.8	HBSL, SMCL	300, 50	14.6	**73.3**	21.4	**261**	**56.9**	< 5.0
Molybdenum, Total	ug/L	EPA 6010B	10.0	4.5	HBSL	30	< 10.0	< 10.0	< 10.0	13.7	< 10.0	< 10.0
Nickel, Total	ug/L	EPA 6010B	5.0	4.8	HBSL	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Potassium, Total	ug/L	EPA 6010B	1000	149	—	—	3,990	2,740	1,770	1,050	2,630	2,320
Silver, Total	ug/L	EPA 6010B	2.0	0.68	HBSL	100	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Sodium, Total	ug/L	EPA 6010B	2000	1460	—	—	11,100	**48,400**	17,400	9,310	**48,900**	23,100
Strontium, Total	ug/L	EPA 6010B	5.0	0.77	HBSL	4000	484	521	1,050	484	1,010	387
Thallium, Total	ug/L	EPA 6020A	0.50	0.22	MCL	2	< 0.50	0.57	< 0.50	< 0.50	< 0.50	0.83
Vanadium, Total	ug/L	EPA 6010B	5.0	0.85	—	—	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Zinc, Total	ug/L	EPA 6010B	15.0	12.0	HBSL	2000	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0	< 15.0
Alkalinity, Total as CaCO3	mg/L	SM 2320B	5.0	5.0	—	—	374	406	273	273	281	226
BOD, 5 day	mg/L	SM 5210B	2.0	2.0	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Carbonaceous BOD, 5 day	mg/L	SM 5210B	2.0	2.0	—	—	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Chemical Oxygen Demand	mg/L	HACH 8000	20.0	7.1	—	—	< 20.0	< 20.0	< 20.0	49.2	< 20.0	< 20.0
Cyanide	mg/L	EPA 335.4	0.01	0.0049	MCL	0.2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phenolics, Total Recoverable	ug/L	EPA 420.4	2.0	1.0	—	—	4.0	< 2.0	2.6	2.2	< 2.0	< 2.0
Total Dissolved Solids	mg/L	SM 2540C	10.0	10.0	SMCL	500	**624**	436	158	418	**598**	276
Total Organic Carbon	mg/L	SM 5310C-11	1.0	0.36	—	—	1.3	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
E.coli	MPN/100mL	SM 9223B	1.0	1.0	MCL	0	< 1.0	< 10.0	< 1.0	< 1.0	< 1.0	< 1.0

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