WATER RELIABILITY STUDY (WRS)

Prepared For:

City of Bangor
WSSN #00380
257 W Monroe St
Bangor, Michigan 49013

and

Michigan Department of
Environment, Great Lakes, and Energy (EGLE)

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Prepared by:

ABONMARCHE
95 West Main Street, Benton Harbor, MI 49022 • 269.927.2295
abonmarche.com

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Executive Summary

1. The City of Bangor owns and operates their water treatment and distribution system. This system includes a ground storage tank, five wells, and a network of pipes that deliver water to 895 customers. An existing wellhead protection area (WHPA) is in place with the Michigan Department of Environment, Great Lakes, and Energy (EGLE) and represents the area underground that contributes groundwater to the water supply wells.

2. The City regularly utilizes four wells that have a combined capacity of 1,770 GPM and a firm capacity of 1,200 GPM with Well 8 out of service. 2023 average daily demands were 178,800 gallons, which was higher than average due to increased water usage for hydrant testing and water tank inspections. As such, projected 5-year and 20-year maximum daily demands were based on 2022 data, which averaged 154,000 gallons per day. A growth rate of 0.25% per year was based on population growth statistics.

   Maximum daily demands in 2029 and 2044 are 27% and 28% of firm capacity, respectively. These figures are well below the 80% threshold for considering implementing additional capacity.

Table 1. City of Bangor Water Usage & Demand Projection Data

Year	Firm Capacity (gpm)	Demand Projections (gpm)		
		Average Daily	Maximum Daily	Peak Instantaneous
2022 (used as current year data)	1,200	107	321	1,283
2029 Projected		108	325	1,299
2044 Projected		112	337	1,349

3. The City of Bangor has an overall well-looped system with strategically placed wells and ground storage tank. Their system, when modeled in WaterGEMS software, showed almost all areas were able to provide at least 1,000 gallons per minute in the event of a fire. The few areas that could not provide adequate fire flow were identified as 5-year capital improvement projects, and 20-year scopes were developed by analyzing potential bottlenecks in the system.

4. Based on findings from this 2024 Water Reliability Study, the following table summarizes the cost associated with proposed 5- and 20-year improvements.

Table 2. Bangor Water System Proposed Improvement Costs

Proposed Improvements	Estimated Cost (2024 Dollars)	Estimated Cost (2029 Dollars)	Estimated Cost (2044 Dollars)
5-Year	$1,089,000	$1,262,000	-
20-Year	$2,906,000	-	$5,248,000

1. Introduction

The City of Bangor has commissioned this study to review the reliability and service provided to its residents and to provide continued guidance on prioritization of necessary improvements to the system for the next 5 and 20 years.

The study has been structured to meet the State of Michigan's requirements (R325.112) for completing a reliability study. The study features details on the computer analysis of the water system in WaterGEMS software. The model was used to determine required upgrade areas and create a proposed improvement plan with associated costs. The study area is defined as the service area for the water system.

2. Water Supply

2.0.1 Source Water & Water Treatment

The City of Bangor currently maintains 5 wells that provide drinking water to users via a groundwater aquifer between 110 feet and 178 feet in depth. These wells are inspected regularly by Peerless Midwest. Wells 3, 7, 8, and 9 are currently active, with Well 5 on standby. These wells have a combined 1,770 GPM capacity as shown below in **Table 3**:

Table 3. City of Bangor Well Data

Well Name	2023 Pumping Capacity (gpm)
No. 3	325
No. 7	325
No. 8	570
No. 9	550
Total Flow	1,770
Firm Capacity*	1,200

**Firm Capacity is the system pumping capacity with the largest well out of service.*

Raw water from the aquifer is pumped up through Bangor's wells and treated before entering the system. Treatment takes place at Wells 3, 7, 8, and 9. All the equipment and chemicals for this process are located at each well house before entering the distribution system. Addition of Chlorine and Phosphate help disinfect the system and keep iron levels low, respectively. Public works staff complete necessary residuals testing to ensure water is safe to drink, following strict guidelines for water quality as established by the Safe Drinking Water Act, Act 399, P.A. 1976 which dictates maximum contaminant levels (MCL) for safe drinking water provided to the public. The Water Quality Reports for 2020, 2021, and 2023 found in **Appendix A** summarize these reported contaminant levels.

The 2023 Water Quality Report stated that Bangor's susceptibility/potential of contamination of source water is "highly susceptible" due to factors such as geologic sensitivity, well

construction, water chemistry, and contamination sources. Staff continue to explore ways to lower the susceptibility rating with the state.

2.0.2 Water Distribution System

2.0.2.1 Transmission & Distribution Mains

The existing water distribution system includes 23.03 miles of water main with services to 895 users. **Tables 4**, **5**, and **6** show Bangor's water system by age, material, and diameter, respectively. **Figures 1**, **2**, and **3** on the following pages show Bangor's water system by age, material, and diameter, respectively.

Table 4. City of Bangor Water Main by Age

Water Main Age (Years)	Length of Water Main (linear foot)	% of Total
0 - 25	6,124	5.1
26 - 50	9,643	7.9
51 - 75	83,191	68.4
76 – 125+	22,644	18.6
Total	**121,602**	**100%**

Table 4 shows that over 86% of the system is greater than 50 years of age, with many pipes dating to the early 1900's. Additionally, **Table 5** below shows that 83.9% of the system is cast iron in material, which has a service life of 75 years.

Table 5. City of Bangor Water Main by Material

Water Main Material	Length of Water Main (linear foot)	% of Total
Cast Iron	102,000	83.9
Ductile Iron	9,945	8.2
Steel	2,976	2.4
Transite	6,681	5.5
Total	**121,602**	**100%**

Table 6 below shows Bangor has 2-inch through 12-inch water main serving its users, with most of the residential areas being served by 2- to 6-inch mains. A portion of the City (13.8%) is serviced by mains 2" and 4" in diameter, which is undersized per the Greak Lakes Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (commonly referred to as "Ten-State Standards").

Table 6. City of Bangor Water Main by Size

Water Main Diameter (inches)	Length of Water Main (linear foot)	% of Total
2	1,332	1.1%
4	15,428	12.7%
6	64,820	53.3%
8	23,258	19.1%
10	14,813	12.2%
12	1,951	1.6%
Total	**121,602**	**100%**

Figure 1. City of Bangor Water Main by Age

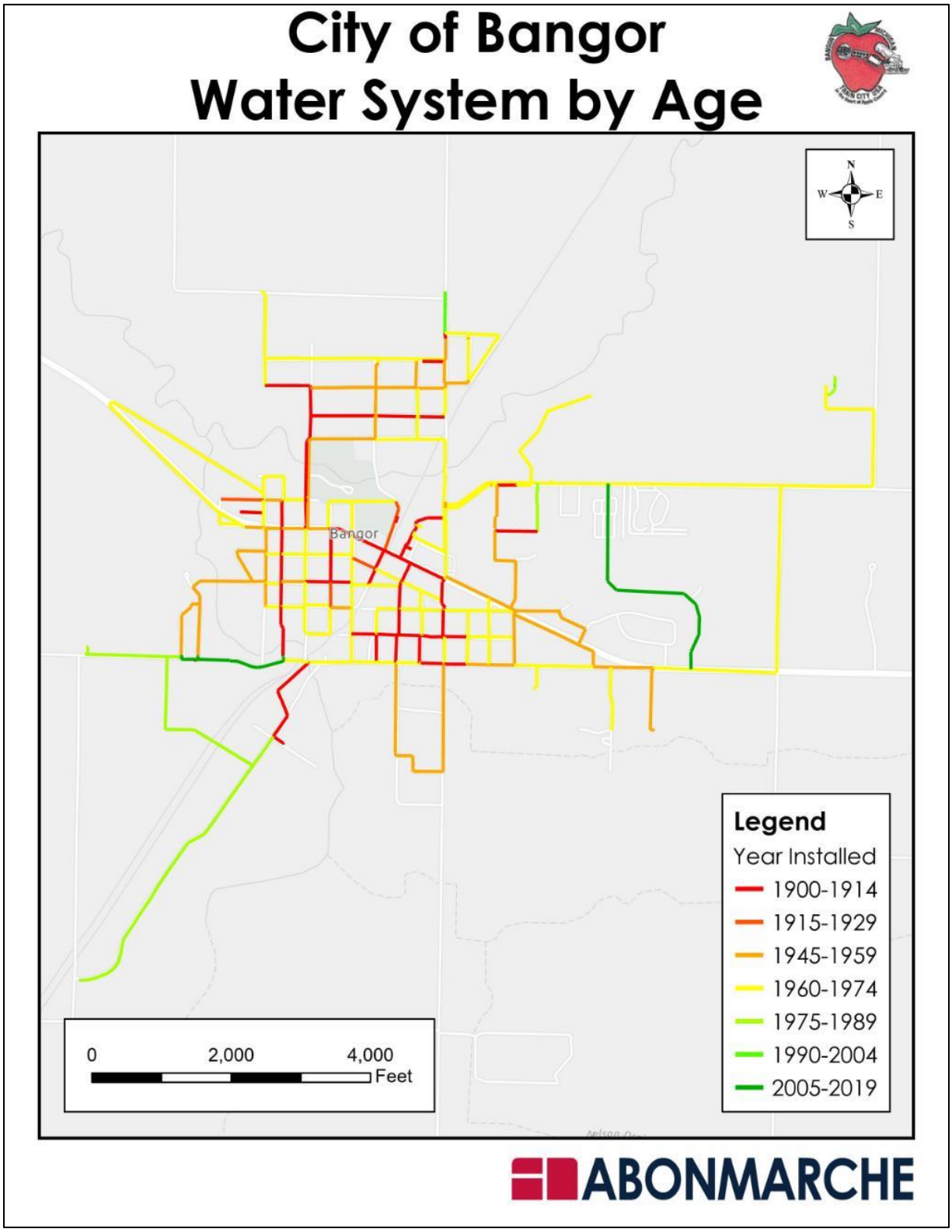


Figure 2. City of Bangor Water Main by Material

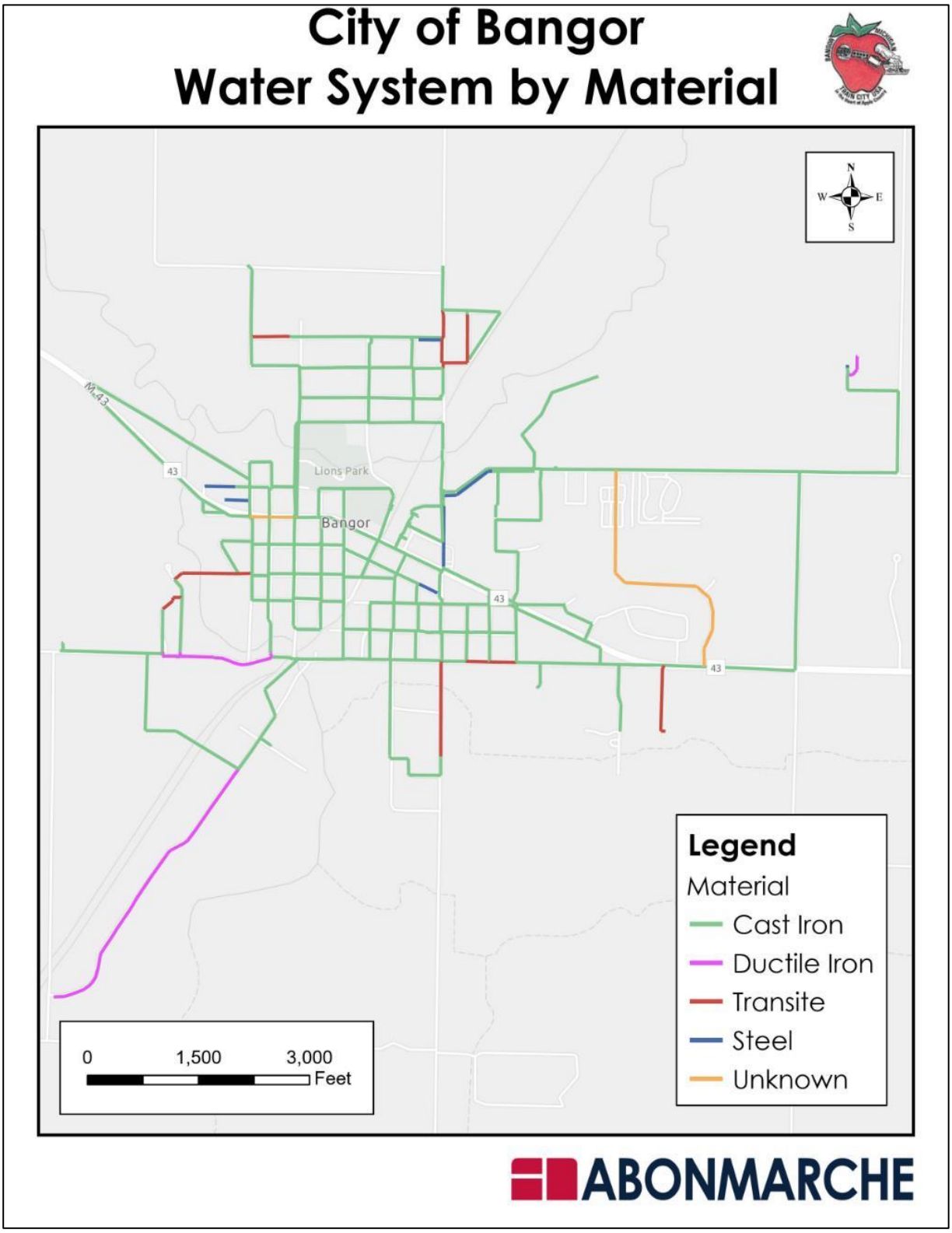
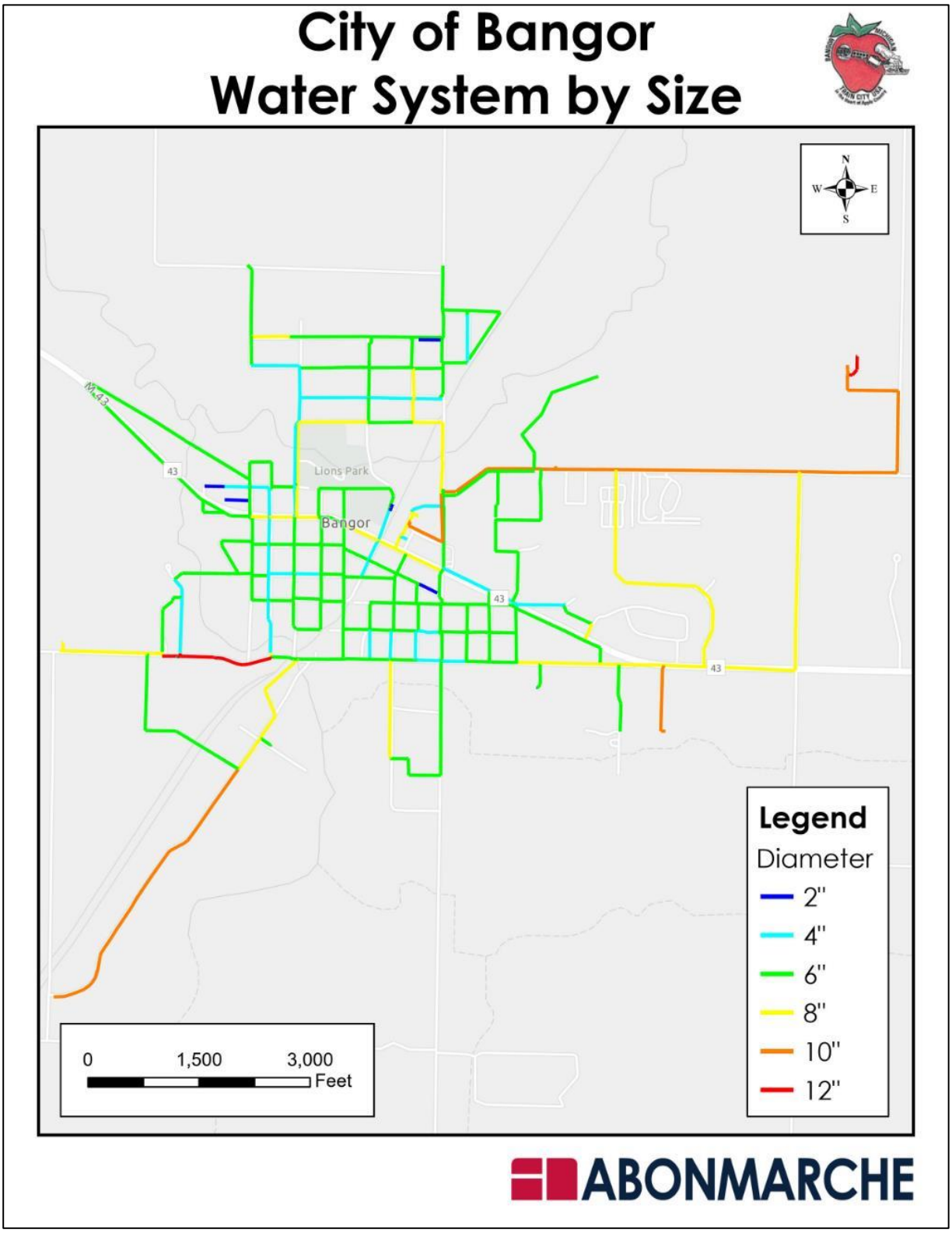


Figure 3. City of Bangor Water Main by Diameter



2.0.2.2 Hydrants and Valves

The city has 143 fire hydrants and 381 total mainline and hydrant auxiliary valves in its distribution system. The locations of these hydrants were collected using GPS by Abonmarche staff in 2023. Hydrant flow tests were also completed by Abonmarche staff in late 2023 per AWWA standards to gather flow data for this study. The flow testing results from these hydrant tests are discussed in greater detail in Section 6.0.1.2 below.

Table 7 below details ISO criteria for fire flows based on proximity to various building types. The minimum residual pressure at the fire flow is commonly required, by the National Board of Fire Insurance Underwriters, to be 20 psi.

Table 7. ISO Criteria for Fire Flows Determined by Proximity of Buildings

Distance Between Buildings (ft)	Needed Fire Flow (gpm)
More than 100	500
31 to 100	750
11 to 30	1,000
10 or Less	1,500

*Dwellings not to exceed two stories in height

2.0.2.3 Storage System

The City utilizes their 300,000-gallon above ground storage tank located on 55 ½ Street to provide water storage for fire protection and improve system pressures. The tank was constructed in 1973 by Caldwell and has a head range of 14.25 feet. The tank meets Insurance Services Office (ISO) standards for firefighting protection within the recommended range of two (2) to four (4) hours. A formal inspection of the tower's condition was completed by Dixon Engineering in 2023. This inspection recommended an estimated $558,000 in repair and improvement work. The most critical aspects of this work were the internal structural repair, along with external and internal repainting, and would end up costing around $410,000.

2.0.2.4 Water Meters and Customers

The City has 895 metered connections. There are 70 meters for municipal use that are exempt from being charged. **Table 8** below details the City's existing active water meters by use.

Table 8. Summary of Existing Active Water Meters by Size

User Type	# of Meters	% of System
Residential	726	81.1
Commercial	89	10.0
Municipal/Exempt	70	7.8
Industrial	9	0.1
Unknown	1	0.0
Total	**895**	**100.0**

2.0.2.5 Emergency Connections

The nearest water distribution systems to the City of Bangor are in Covert, MI (7 miles), Hartford, MI (9 miles), and Bloomingdale, MI (11 miles). These systems are too far away to be used as a logical emergency connection. Instead, the City depends on the usage of four (4) out of the five (5) of its wells, keeping one well unused but on standby as an emergency well.

Should all wells not be available for potable water in an emergency situation, Bangor will utilize bottled water for its customers, plus contract with a water hauler for additional sources.

2.0.2.6 Water Quality

Water Quality Reports are created annually and made available to the public via the City's website. Water Quality Reports from 2020, 2021, and 2023 can be found in **Appendix A.**

3. Population and Customers

3.0.1 Population Data and Projections

The Southwest Michigan Planning Commission (SWMPC) creates a State of the Region Report to examine demographics and performance of Southwest Michigan Counties. The latest report was released in 2013. Utilization of this comprehensive report was key for determining population projections for the City of Bangor, the surrounding Township, and the County as a whole. Additionally, a 2012 report from SWMPC entitled "Southwest Michigan Comprehensive Economic Development Strategy" was utilized for population projections.

Conclusions from these reports were a near-zero population change in the coming years for Cities within Van Buren County. Villages are expected to experience slight population declines, while Townships will see slight population increases. This will result in modest population growth for the county, as seen in **Table 9** below.

The projections shown in **Table 9** are based on the reports referenced above which are included in **Appendix B.** Given the SWMPC's projected flat growth of Cities in Van Buren County, a growth rate of 0.25% was assumed to show minor growth in the coming years. Because of the minimal developable land within the city, there is little room for population growth.

Table 9. City of Bangor Population Data and Projections

Population	Historical Data			Projected Data			
	2010	2020	% Change	2025	2030	2035	2043
City of Bangor	1,885	2,006	6.9%	2,031	2,056	2,082	2,124
Van Buren County	76,258	75,658	-0.9%	83,652*	85,053*	85,002*	N/A

** = projections from 2012 Southwest Michigan Comprehensive Economic Development Strategy*

3.0.2 Top Water Users

Table 10 below shows the top water consumers in the water system for 2022. The area is rich in agriculture, specifically in various fruits such as apples and blueberries.

Table 10. 2022 Top Water Consumers in the City of Bangor System

Company	2022 Company Water Usage (Gallons)
Marrone Michigan Manufacturing	744,844
Freestone Pickle	260,779
Getman Corporation	134,830
Green Sprout	52,359

4. Historic and Existing Demands

Water demand is the volume of water consumed by users over a given period of time. It can be defined in many terms, including average daily, maximum daily, and peak instantaneous demand, as further explained below.

The **average daily demand** is calculated by dividing the total water consumed by the community over a calendar year and dividing it by 365 days. Total consumption is derived from the year-end pumpage reports.

The **maximum daily demand** observed in a year is typically recorded in a water supply's year-end pumpage report. If the maximum daily water use recorded in a year is not known, a 3x multiplier is applied to the average daily demand.

The **peak instantaneous demand** represents the peak demand a water supply may face in a short period of time. EGLE guidance assumes the peak instantaneous demand is four times the maximum day demand.

4.0.1 Well Pump Production Data

Production history from 2012 through 2023 is displayed in **Table 11** on the following page.

Table 11. City of Bangor Historical Water Production in Million Gallons (MG)

Year	Well 3	Well 7	Well 8	Well 9	Total Water Pumped	% Change from Previous Year
2012	Data not available				64.5	-
2013					76.7	+16
2014					58.6	-31
2015	11.5	12.5	18.7	14.5	57.2	-3
2016	6.2	10.6	19.1	20.3	56.1	-2
2017	7.8	11.1	21.7	14.8	55.4	-1
2018	6.7	10.7	26.5	12.2	56.2	+1
2019	5.1	11.7	25.5	10.1	52.4	-7
2020	8.9	12.2	17.0	17.2	55.3	+5
2021	13.6	4.5	10.8	23.9	52.7	-5
2022	15.4	4.5	19.7	16.5	56.2	+6
2023	17.5	12.6	16.1	19.1	65.3	+16

The average annual water pumped since 2012 is 58,883,333 gallons. It should be noted that in 2023, extensive testing of hydrants and valves occurred for both the Water Asset Management Plan and Reliability Study. Additionally, Bangor's water storage tank was completely drained and inspected. These two activities resulted in a higher-than-normal year for water usage but is not reflective of any population or business growth in Bangor. **Table 12** below shows Bangor's historic average daily and maximum daily demands.

Table 12. City of Bangor Historical Water Demands

Year	Average Daily Demand (gallons)	Maximum Daily Demand (3x multiplier) (gallons)	Maximum Daily Demand (recorded value) (gallons)
2019	143,562	430,685	N/A
2020	151,507	454,521	
2021	144,384	433,151	
2022	153,973	461,918	858,000 (5.6x)
2023	178,904	536,712	1,286,000 (7.2x)

Bangor's present peak instantaneous demand is based on 2023 data:

*Peak Instantaneous demand = 4 * Maximum Daily Demand = 4 * 536,712 = 2,146,848 gallons / 1,440 minutes = 1,491 gallons per minute*

5. Projected Future Demands

Utilizing an assumed growth rate of 0.25% per year as previously described in Section 3.0.1, projections were similarly applied to water demands in the city as shown in **Table 13** below.

The maximum daily demand is based on the measured value of three (3) times average daily demand per EGLE guidance. Additionally, EGLE recommends a six (6) times multiplier for maximum hourly demands, and four (4) times the maximum daily demand to obtain peak instantaneous demands.

It should be noted that "current" data utilized for future demands was 2022 pumped data, as 2023 values were significantly higher due to hydrant flushing and water tower draining activities.

Table 13. City of Bangor Projected Water Demands

Year	Demand Projections					
	Annual Demands (gallons)	Average Daily (gallons)	Average Daily (gpm)	Maximum Daily (gpm)	Maximum Hourly (gpm)	Peak Instantaneous Demand (gpm)
2022 (utilized as "current" 2024 data)	56,200,000	153,972	107	321	642	1,283
2029 (5-Year)	56,906,021	155,906	108	325	650	1,299
2044 (20-Year)	59,077,749	161,856	112	337	674	1,349

A 0.25% growth rate over 20 years yields a future annual demand of over 59 million gallons for Bangor. This population growth rate translates to modest increases in pumped water for Bangor residents and businesses. As further discussed in Section 6 below, these demands and projections were inputted in WaterGEMS software to ensure 5- and 20-year demand scenarios would be adequately served by Bangor's water system.

5.0.1 Firm Capacity

The Michigan Safe Drinking Water Act (Act 399, PA 1976) requires municipal systems to provide sufficient capacity to meet the approved finished water supply requirements. Firm capacity refers to the production capability of a water system with the largest pump or treatment train out of service. As previously mentioned in **Table 3**, Bangor's firm capacity based on 2023 pump inspections is 1,200 GPM. Well 8 produces 570 gpm and would be the largest well out of service.

Table 14. City of Bangor Firm Capacity Analysis

Year	Firm Capacity (gpm)	Maximum Daily (gpm)	Peak Instantaneous Demand (gpm)
2022 (utilized as "current" 2024 data)	1,200	321	1,283
2029 (5-Year)		325	1,299
2044 (20-Year)		337	1,349

EGLE guidance requires firm capacity to be compared against maximum daily demands and peak instantaneous demands. When compared against maximum daily demands in **Table 14** above, which is already three times the average daily demand, firm capacity is well above any maximum demands expected in the 20 years.

When firm capacity is compared against calculated peak instantaneous demands, calculated peak numbers are slightly higher than firm capacity. Peak instantaneous demands are four times the maximum daily demands, which are three times the average daily demands. Overall, this equates to 12 times the average daily demand from known data in Bangor. Even if this peak instantaneous demand value were to be reached at any given moment in the coming 20 years, Bangor would have three wells plus their ground storage tank to supply water.

Table 14 above indicates that the system is set up for the coming years and should be well-served unless supply issues arise and/or unpredicted growth occurs.

6. Hydraulic Analysis

Bentley's WaterGEMS modeling software was utilized for modeling Bangor's water system. GIS data from their water system was used to input the City's water system, including information such as age, material, diameter, and geometry.

6.0.1 Model Inputs, Setup, and Calibration

6.0.1.1 Base Physical Data in WaterGEMS

The City of Bangor in collaboration with Abonmarche reviewed and updated their water distribution system in GIS in 2023, allowing for the most accurate water system to be the baseline for the water model. Any unknown water main sizes were determined by checking record drawings and turning valves, counting the number of turns to correlate with main size. Any unknown water main ages were determined by checking age on hydrants for a relative age range of the connected main. Unknown water main materials were interpolated based on surrounding mains.

In addition to water distribution assets, pump data was inputted into WaterGEMS to allow simulation of the water system. Pump curves were established based on recent inspections in

order to show real-world conditions. Similarly, the City's ground storage tank was inputted into WaterGEMS, including operating water levels, elevations, and storage capacity.

6.0.1.2 Demands

In addition to accurately modeling physical conditions of the water system in WaterGEMS, inputting accurate demands is crucial to a well-modeled system. Bangor's water demands were inputted into the software based on recorded data from 2022 & 2023. Demands were divided among the system's 364 junctions, which are points between each water main segment. This simulates the demands seen across the City's 895 customers. Top users were manually inputted at their physical location to ensure demands were accurately shown in those areas of town. Additionally, demands were spread throughout the day in a diurnal curve, which represents water usage throughout a typical 24-hour day for a typical community. Higher usage values in the morning hours of 6 to 9 AM and evening hours of 5 to 10 PM were inputted for accuracy.

When modeling the 5- and 20-year scenarios, demands were updated per junction based on the assumed 0.25% growth rate per year for the coming 20 years. This ensured all assumptions about Bangor's growth were incorporated into the model.

6.0.1.3 Hydrant Field Tests

In late 2023, Abonmarche staff performed 10 hydrant tests throughout the City of Bangor for use in calibrating the Bangor WaterGEMS model. Tests were selected on mains of different size, age, material, and physical location to obtain a representative sample. **Table 15** below shows the age, material, and diameter of the mains on which hydrants were tested. **Table 16 and Figure 4** on page 15 shows the 10 tests selected with their results.

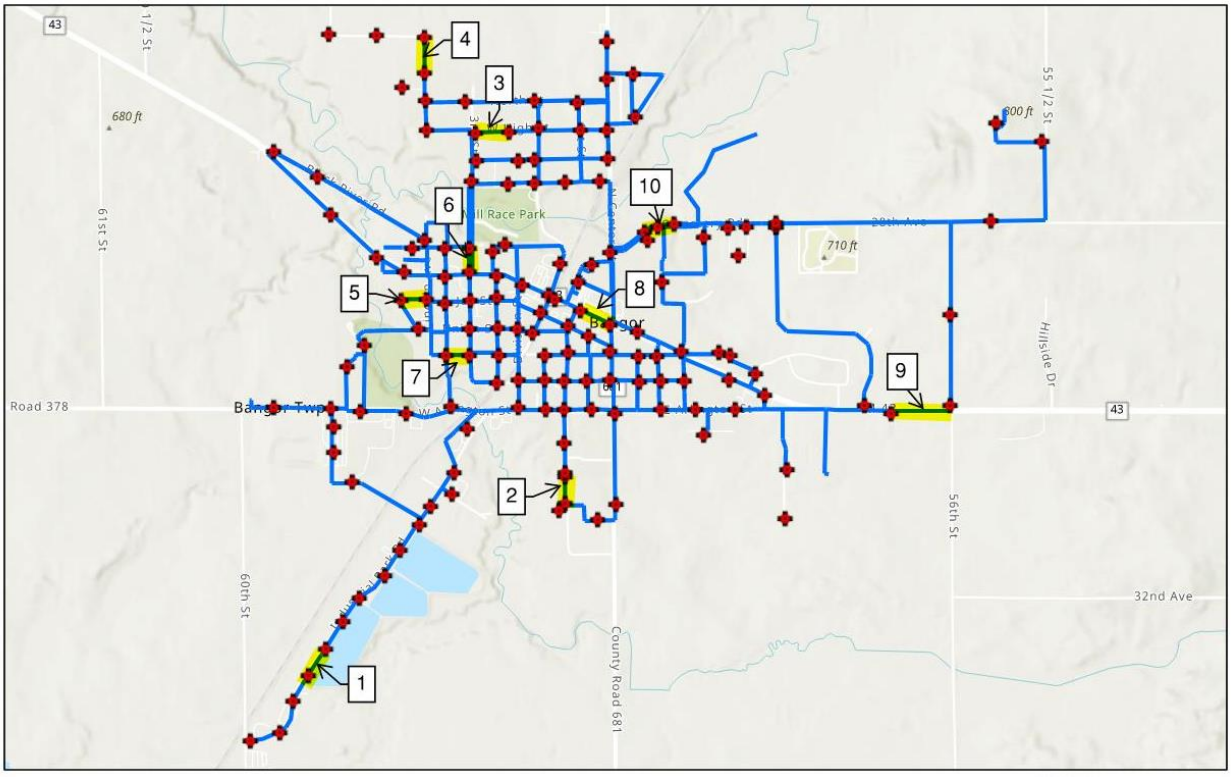
Table 15. Selected Hydrant Tests – Water Main Information

Test Number	Test Location	Water Main Installation Year	Water Main Material	Water Main Diameter (inches)
1	Industrial Park Rd	1980	Ductile Iron	10
2	S Walnut St	1952	Cast Iron	8
3	W High St	1948		6
4	Greenhouse Rd	1972		6
5	Cherry Ct	1955		6
6	Hamilton Ave	1913		4
7	W Cass St	1962		6
8	W Monroe St	1913		8
9	M 43	1971		8
10	Cemetery Rd	1972		10

Table 16. Selected Hydrant Tests for Model Calibration

Test Number	Test Location	Residual/Test Hydrant Number	Flow Hydrant Number	Static Pressure at Residual Hydrant (PSI)	Residual Pressure at Residual Hydrant (PSI)	Observed Flow at Flow Hydrant (GPM)	Calculated Flow at 20 PSI at Flow Hydrant (GPM)
1	Industrial Park Rd	31	32	64	36	**888**	**1,133**
2	S Walnut St	123	124	72	24	**597**	**623**
3	W High St	59	60	64	43	**856**	**1,276**
4	Greenhouse Rd	3	2	70	22	**581**	**594**
5	Cherry Ct	17	18	64	40	**904**	**1,254**
6	Hamilton Ave	84	8	70	54	**1,007**	**1,863**
7	W Cass St	85	40	64	53	**872**	**1,843**
8	W Monroe St	103	104	70	58	**1,007**	**2,176**
9	M 43	73	72	58	49	**822**	**1,789**
10	Cemetery Rd	65	63	72	64	**1,163**	**3,194**

Figure 4. Hydrant Test Locations



6.0.1.4 Calibration

Water Gems uses a "Darwin Calibrator" in order to calibrate the system based on AWWA field hydrant tests performed. Residual pressures observed while the hydrant is flowing are inputted as a Hydraulic Grade Line (HGL) in Darwin Calibrator. Flows outputted at the hydrant are additionally inputted. The Calibrator tool utilizes two main parameters to match model conditions to the inputted fire flows: C-factors (internal roughness of pipes) and demands in the system. The calibrator is able to run 10,000 scenarios to match the model's HGL to the field-observed HGL by changing the two parameters.

Limits were set in the program to control how much the C-factors and demands could be modified. C-factor upper and lower limits were based on water main age and material, and demand limits were set based on historic data to establish realistic high and low points.

It is preferrable to have HGL model and field values calibrated within 9% of each other; **Table 17** below shows the results in the Bangor model. The average variance at all 10 test locations was -1.88%, indicating an acceptable calibrated system.

Table 17. Model Calibration Results

Test Number	Residual/Test Hydrant Number	Flow Hydrant Number	Measured Hydraulic Grade Line (ft)	Modeled Hydraulic Grade Line (ft)	Percent Variance %
1	31	32	743.16	687.11	-7.54%
2	123	124	721.44	773.58	7.23%
3	59	60	761.33	740.10	-2.79%
4	3	2	704.82	745.11	5.72%
5	17	18	753.40	753.04	-0.05%
6	84	8	784.74	746.23	-4.91%
7	85	40	790.43	758.71	-4.01%
8	103	104	788.98	752.21	-4.66%
9	73	72	796.19	778.08	-2.27%
10	65	63	800.84	757.06	-5.47%

6.0.2 Results

Once the Darwin calibrator has produced an acceptable scenario, the modified C-factors and demands were applied and a calibrated scenario was established. This calibrated scenario is the basis for simulating current fire flow conditions, 5-year conditions, and 20-year conditions.

6.0.2.1 Current Conditions

Fire flow conditions were simulated City-wide, with minimum pressures of 20 PSI. Results of the WaterGEMS Fire Flow simulation showed that, with the exception of three areas in town, flows between 1,000 to 2,000 gpm would occur throughout Bangor. Please refer to **Appendix C** for the results table of fire flows for current conditions. Simulation of current conditions with fire

flows showed areas less than 1,000 GPM, which formed the basis of 5-year capital improvement plans, as described in 6.0.2.2 below.

6.0.2.2 5-Year Improvements

Once the current year calibrated scenario was run with fire flow simulation, a 5-year scenario was created that reflected 2029 demands and looked to fix areas less than 1,000 GPM. The three areas in town identified had fire flows less than 300 gpm and are likely due to undersized water main, dead ends, and older pipe with lower C values. Scenarios 1, 2, and 3 described below were identified for improvements:

1. **Washington Street & Alley directly south of Washington Street**
    - West of Lincoln Street, records indicate these two dead-end segments of water main are 2" steel.
        - Dead end junction observed 189 GPM on Washington St
        - Dead end junction observed 213 GPM on alley

2. **Charles Street Dead End**
    - East of Maple Street, water main on Charles Street dead ends just west of North Center Street per available records. Water Main on this segment is 2" steel with an unknown installation date.
        - Dead end junction observed 230 GPM on Charles St

3. North Street Dead End

- Between First St and N Center St, there is a 2" steel line on North Street that likely feeds homes on this stretch.
  - Dead end junction observed 216 GPM on North St

The three areas above were modified in the 5-year scenario in WaterGEMS to be replaced with 8-inch ductile iron water main and loop into nearby connecting points, eliminating dead ends. **Table 18** below shows the fire flow results currently and after implementing changes:

Table 18. Observed Flow Changes, 5-Year Scenarios

Area	Hydrant/Valve Number	Current Observed Flow, 20 PSI (gpm)	5-Year Observed Flow with Improvements, 20 PSI (gpm)
1. Washington Street	H-125	1,214	1,899
	J-264	213	1,898
	J-267	189	1,899
2. Charles Street	J-276	230	1993
3. North Street	J-322	216	N/a – pipe to be capped and service lines switched to water main to north

The three areas above were added to the 5-Year Capital Improvements plan in order to improve fire flows.

6.0.2.3 20-Year Improvements

Results of the currently calibrated system showed that fire flows of at least 1,000 gpm were observed throughout the system, with the exception of the scope identify for 5-year improvements. For 20-year scoping, dead end mains, undersized mains, and pipes with low C-factors (past useful life) were considered for possible improvements. Scenarios 4, 5, and 6 were analyzed for possible improvements to the system:

4. Monroe Avenue

- Between Center Street and Randolph Street, there is a 4-inch 1952 cast iron main. Monroe west of Center has 8-inch water main, and Monroe east of Randolph has 6-inch water main. This portion of the main is centrally located in the city's system and appears to be a bottleneck.

Table 19 on the following page shows the effects of upsizing this stretch of water main to 8-inch ductile iron. Although fire flows are already adequate here, the hydrant & junction near the center of the stretch show improvements of almost 500 gpm after upsizing. Additionally, this stretch of main is likely slated for replacement from an asset management standpoint due to its size and age. As such, Monroe Street was added to the 20-Year CIP.

5. Greenhouse Road

- Greenhouse Road in the northwest portion of the city has one of the longest dead-end mains. Hydrant H-143 at the end has a current fire flow capacity of 1,097 gpm at 20 PSI. The main is 6-inch cast iron from 1971. Looping could occur by running water main southwest to water main under M-43, but the environmental impacts during construction under the Black River and surrounding forest appear greater than any fire flow improvements.

A 20-year scenario was run that upsized water main from 3rd Street to Greenhouse road to 8-inch ductile iron. **Table 19** on the following page shows modest gains in fire flows at the end of the line. However, these improvements were not enough to merit inclusion on the 20-year CIP; as such, Scenario 5 was not included on the final CIP list.

6. Industrial Drive

- Industrial Drive in the southwest portion of the city has many large water users and has a dead end.

A 10-inch ductile iron water main loop on 60th Street was modeled to consider possible improvements in flow. **Table 19** below shows gains in flows ranging from 78 to 245 GPM. Discussions with business owners have revealed concerns with water quality due to the dead-end water main on Industrial Drive. Looping of water main on 60th Street was included in the 20-year CIP as a solution to water quality and potential future expansion of businesses along this corridor.

Table 19. Observed Flow Changes, 20-Year Scenarios

Area	Hydrant/Valve Number	Current Observed Flow, 20 PSI (gpm)	20-Year Observed Flow with Improvements, 20 PSI (gpm)
4. Monroe Street	J-226	1,988	2,012
	H-110	1,516	2,015
	J-223	1,875	2,008
5. Greenhouse Road	H-143	1,097	1,407
6. Industrial Drive	H-32	1,410	1,655
	J-38	1,633	1,711
	H-37	1,464	1,662

7. Proposed Improvement Plan

Construction cost estimates were developed for both 5- and 20-year improvements identified in Section 6 above. Estimated construction costs in **Tables 20** and **21** include complete street replacement items and consideration of nearby utility replacements. It is recommended that a "dig-once" philosophy be implemented with capital improvements due to high costs, construction impacts, and conditions of the City's sewer and road systems.

7.0.1 5-Year Improvements Plan

The three areas identified in Section 6.0.2.2 above were placed on the 5-year capital improvement plan and are summarized in **Table 20** below. Full estimates can be found in **Appendix D**. A 3% inflation factor was applied to consider costs at the end of the 5-year timeframe in 2029.

Table 20. Proposed 5-Year CIP Projects

Project Number	Project	Estimated 2024 Construction Cost (includes contingency & engineering)	Estimated 2029 Construction Cost (includes contingency & engineering)
1	Washington Street; Alley south of Washington Street	$756,000	$876,000
2	Charles Street Dead End	$291,000	$337,000
3	North Street Dead End	$42,000	$49,000
	Total	**$1,089,000**	**$1,262,000**

7.0.2 20-Year Improvements Plan

Table 21 below shows the construction cost estimate for replacement of 4-inch 1952 cast iron water main on Monroe Street from Center to Randolph Street with 8-inch ductile iron water main. Additionally, looping of 60th Street from County Road 378 to Industrial Drive was included. A 3% annual inflation factor was applied to consider costs at the end of the 20-year timeframe in 2044.

Table 21. Proposed 20-year CIP Projects

Project Number	Project	Estimated Construction Cost (includes contingency & engineering)	Estimated 2044 Construction Cost (includes contingency & engineering)
1	Monroe Street – Center to Randolph Streets	$835,000	$1,508,000
2	60th Street – County Road 378 to Industrial Drive	$2,071,000	$3,740,000
	Total	**$2,906,000**	**$5,248,000**

8. Conclusions

The vast majority of Bangor's water distribution system has access to at least 1,000 gallons per minute for fire-fighting situations. Additionally, the system has adequate pressures and flows to serve everyday demands currently and for the coming 20 years.

The few areas identified in the system with fire fighting flows less than 1,000 gpm were slated for 5-year improvements, and 20-year recommendations came from analysis of potential weak points in the system. These improvements will help eliminate undersized mains, dead ends, and bottlenecks to improve flows in the overall system.

Appendix A
Water Quality Reports

2020 Water Quality Report for the City or Bangor

Consumer Confidence Report

On the Quality of Tap Water Provided by the City of Bangor WSSN 0380

The bottom line is the City of Bangor's water supply is complete safe. This report is emailed to area media outlets such as the daily and weekly newspapers, radio stations and television stations servicing the area. It is also mailed to the county health department. Please take the time to review the report. The report is also posted on the City's Website, (www.cityofbangormi.org) under the button titled "Water Report". In addition to posting the City's Website, this report is being advertised in the Reminder, and copies are available at City Hall. It is not being mailed out to all water customers.

Water Quality Report for the City of Bangor

This report covers the drinking water quality for the CITY OF BANGOR for the 2020 calendar year. This information is a snapshot of the quality of the water that we provided to you in 2020. Included are details about where your water comes from, what it contains, and how it compares to United States Environmental Protection Agency (U.S. EPA) and state standards.

Your water comes from FOUR groundwater wells, each over 64 TO 219 FEET. The State performed an assessment of our source water to determine the susceptibility or the relative potential of contamination. The susceptibility rating is on a seven-tiered scale from "very-low" to "very-high" based on geologic sensitivity, well construction, water chemistry and contamination sources. The susceptibility of our source is HIGHLY SUSCEPTIBLE.

There are significant sources of contamination which include OLD ABANDON WELLS, OLD FUEL TANKS AND OLD INDUSTRIES SITES in our water supply. We are making efforts to protect our sources by SECURING MONIES TO CAP OFF OLD WELLS AND WE HAVE COMPLETED A WELLHEAD PROTECTION PROGRAM.

If you would like to know more about this report, please contact: CITY MANAGER TOMMY SIMPSOM 427-5831, or the WATER DEPARTMENT SUPERVISOR STEVEN LOWDER 312-4298.

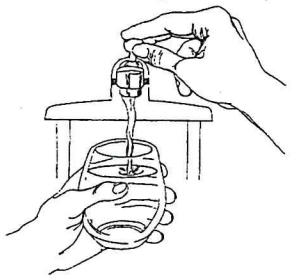
Contaminants and their presence in water: Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the U.S. EPA's Safe Drinking Water Hotline (800-426-4791).

Vulnerability of sub-populations: Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune systems disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. U.S. EPA/Center for Disease Control guidelines on appropriate means to lessen the risk of infection by Cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (800-426-4791).

Sources of drinking water: The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. Our water comes from wells. As water travels over the surface of the land or through the ground, it dissolves naturally-occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Contaminants that may be present in source water include:

- **Microbial contaminants**, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations and wildlife.
- **Inorganic contaminants**, such as salts and metals, which can be naturally-occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining or farming.
- **Pesticides and herbicides**, which may come from a variety of sources such as agriculture and residential uses.
- **Radioactive contaminants**, which can be naturally occurring or be the result of oil and gas production and mining activities.
- **Organic chemical contaminants**, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, and septic systems.



In order to ensure that tap water is safe to drink, the U.S. EPA prescribes regulations that limit the levels of certain contaminants in water provided by public water systems. Federal Food and Drug Administration regulations establish limits for contaminants in bottled water which provide the same protection for public health.

Water Quality Data

The table below lists all the drinking water contaminants that we detected during the 2020 calendar year. The presence of these contaminants in the water does not necessarily indicate that the water poses a health risk. Unless otherwise noted, the data presented in this table is from testing done January 1 through December 31, 2020. The State allows us to monitor for certain contaminants less than once per year because the concentrations of these contaminants are not expected to vary significantly from year to year. All the data is representative of the water quality, but some are more than one year old.

Terms and abbreviations used below:

- Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
- Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.
- Maximum Residual Disinfectant Level (MRDL): The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- Maximum Residual Disinfectant Level Goal (MRDLG): The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- N/A: Not applicable
- ND: not detectable at testing limit
- ppm: parts per million or milligrams per liter
- ppb: parts per billion or micrograms per liter
- Action Level (AL): The concentration of a contaminant which, if exceeded, triggers treatment or other requirements that a water system must follow.
- Level 1 Assessment: A study of the water supply to identify potential problems and determine (if possible) why total coliform bacteria have been found in our water system.

1Monitoring Data for Regulated Contaminants

Regulated Contaminant	MCL, TT, or MRDL	MCLG or MRDLG	Level Detected	Range	Year Sampled	Violation Yes/No	Typical Source of Contaminant
Arsenic (ppb)	10	0	6	ND to 6	9/19/12 5/1/20	N	Erosion of natural deposits; Runoff from orchards; Runoff from glass and electronics production wastes
Barium (ppm)	2	2	.11	NA	05/03/16	N	Discharge of drilling wastes; Discharge of metal refineries; Erosion of natural deposits
Nitrate (ppm)	10	10	2.2 mg/l	ND to 2.2 mg/l	2020	N	Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits
Fluoride (ppm)	4	4	3.0 mg/l	.10 to 11 mg/l	5/18/20	N	Erosion of natural deposits; Water additive which promotes strong teeth; Discharge from fertilizer and aluminum factories
Sodium[1] (ppm)	N/A	N/A	17	ND to 17	4/17/19 12/31/19	N	Erosion of natural deposits
TTHM Total Trihalomethanes (ppb)	80	N/A	12.3	NA	08/07/19	N	Byproduct of drinking water disinfection
HAA5 Haloacetic Acids (ppb)	60	N/A	3.0	NA	08/05/19	N	Byproduct of drinking water disinfection
Chlorine[2] (ppm)	4	4	.59	.34 to .74	10/01/18 12/31/19	N	Water additive used to control microbes
Inorganic Contaminant Subject to Action Levels (AL)	Action Level	MCLG	Your Water[3]	Range of Results	Year Sampled	Number of Samples Above AL	Typical Source of Contaminant
Lead (ppb)	15	0	ND to .005 mg/l	n/a	6/9/20	0	Lead service lines, corrosion of household plumbing including fittings and fixtures; Erosion of natural deposits
Copper (ppm)	1.3	1.3	ND to 0.53 mg/l	n/a	6/9/20	0	Corrosion of household plumbing systems; Erosion of natural deposits

[3] Ninety (90) percent of the samples collected were at or below the level reported for our water.

This is an alert about your drinking water and a cosmetic dental problem that might affect children under the age of 9. At low levels, fluoride can help prevent cavities, but children drinking water containing more than 2.0 mg/l of fluoride May develop cosmetic discoloration of their permanent teeth (dental fluorosis). The drinking water provided by the City of Bangor comes from 4 wells. At one of these locations on August 19, 2019 the level of fluoride was 11.0 mg/l. At 2 locations the level was 3.1 and 3.2 mg/l on October 28, 2019. Then on May 18, 2020 the level at well #7 was 3.0. Proper sampling was done and well 7 is now sampled every quarter for fluoride to ensure it is below 2.0 mg/l.

Dental Fluorosis in its moderate or sever forms may result in a brown staining and/or pitting of the permanent teeth. This problem only occurs in developing teeth before they erupt from the gums. Children under the age of 9 should be Provided with alternative sources of drinking water or water that has been treated to remove the fluoride.

Information about lead: If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. CITY OF BANGOR is responsible for providing high quality drinking water, but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you have a lead service line it is recommended that you run your water for at least 5 minutes to flush water from both your home plumbing and the lead service line. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

Infants and children who drink water containing lead could experience delays in their physical or mental development. Children could show slight deficits in attention span and learning abilities. Adults who drink this water over many years could develop kidney problems or high blood pressure.

Copper is an essential nutrient, but some people who drink water containing copper in excess of the action level over a relatively short amount of time could experience gastrointestinal distress. Some people who drink water containing copper in excess of the action level over many years could suffer liver or kidney damage. People with Wilson's Disease should consult their personal doctor.

Our water supply has0 lead service lines and ABOUT 400 service lines of unknown material out of a total of 1100 service lines.

Monitoring and Reporting to the Department of Environment, Great Lakes, and Energy (EGLE) Requirements: The State of Michigan and the U.S. EPA require us to test our water on a regular basis to ensure its safety. We met all the monitoring and reporting requirements for 2020.

We will update this report annually and will keep you informed of any problems that may occur throughout the year, as they happen. Copies are available at CITY HALL 257 W. MONROE and D.P.W. 421 W. ARLINGTON. This report can be seen on our city website at www.cityofbangormi.org.

We invite public participation in decisions that affect drinking water quality. THE COUNCIL MEETS EVERY FIRST AND THIRD MONDAY NIGHT AT 7:00 PM AT THE CITY HALL COUNCIL CHAMBERS, 257 W. MONROE STREET. For more information about your water, or the contents of this report, contact[Steven Lowder at 421 W. Arlington Street or call 269-312-4298. For more information about safe drinking water, visit the U.S. EPA at http://www.epa.gov/safewater.

EGLE

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
DRINKING WATER AND ENVIRONMENTAL HEALTH DIVISON

CONSUMER CONFIDENCE REPORT FOR COMMUNITY WATER SUPPLY
CERTIFICATE OF DISTRIBUTION

Issued under authority of the Safe Drinking Water Act, 1976 PA 399, and Administrative Rules, as amended.
Failure to submit certification is a violation of the Act and may subject the water supply to enforcement penalties.

Supply Name: City of Bangor County: Van Buren WSSN: 0380

Population: ☐ 500 or fewer people ☒ 501 – 9,999 people ☐ 10,000 or more people

Community water supplies must confirm that the Consumer Confidence Report (CCR) and any enclosed Public Notices (PN) or notices of CCR availability, have been distributed to customers by July 1 as required under administrative rules R 325.10415 and R 325.10404(4)(c). Supplies must also certify that the information contained in the CCR is correct and consistent with the compliance monitoring data previously submitted to the Michigan Department of Environment, Great Lakes, and Energy (EGLE). **Return the certification to the appropriate EGLE district office by October 1.** For addresses, visit Michigan.gov/CommunityWater, then click on District Offices Map and Contact Information.

Method of delivery to EGLE

☒ Mail ☐ Email ☐ Hand Delivery ☐ Other _____ Date delivered: _____

Method of delivery to Local Health Department

☒ Mail ☐ Email ☐ Hand Delivery ☐ Other _____ Date delivered: _____

Method or combination of methods to directly deliver CCR to each bill paying customer. Check all that apply.

☐ Mail or hand deliver a paper copy of CCR. Date(s) mailed or hand delivered: _____
☐ Mail or hand deliver notification that the CCR is available at a direct URL. Date(s) delivered to customers: _____
☐ Email notification that CCR is available at direct URL: Date(s) emailed: _____
☐ Email notification that CCR is attached to the email. Date(s) emailed: _____
☐ Email notification that CCR is embedded in the email. Date(s) emailed: _____

If using notification of CCR availability:

1. Mail a paper CCR to customers who request it and to customers known to be incapable of receiving electronically.
2. Include a copy of the notification to EGLE district office with this certification form.
3. Explain the nature of the notification, prominently display the direct URL, include statement how to request a paper copy.

> Example of Notification of CCR Availability Subject Line: 2018 Drinking Water Quality Report Available.
> Message: Your annual report on the source and quality of your drinking water is available online at **www.anytown.gov/waterqualityreport**. To have a copy mailed to you, contact Anytown at 555-111-1111 or water@anytown.gov.

☐ **Option for supplies serving fewer than 10,000 persons**: Publish entire report in newspaper, and notify customers via newspaper(s) in which CCR published, mail, email or hand delivery that individual copies will not be mailed, and include statement how to request a paper copy.
Date(s) of publication: _____

☐ **Option for supplies serving 500 or fewer persons**: Notify customers via mail, email, hand delivery or, with EGLE approval, posting in public places, that a copy of the report is available from the water supply on request.
Date(s) of notification: _____

Post on Internet (required for supplies serving ≥100,000, optional for others)

☒ Internet address: _____ Date accessible: 6/28/22

"Good Faith" efforts to reach non-bill-paying consumers (in addition to the method(s) above). Check all that apply.

☐ Mail the report to all postal patrons. Zip codes and dates mailed: _____
☐ Mail to each service connection physical address. Date(s) mailed: _____
☐ Advertise the availability of the report in the newspapers, on TV, and on the radio.
☐ Publish the report in a local newspaper.
☒ Post the report in public places such as cafeterias in public buildings, libraries, churches, and schools.
☐ Deliver multiple copies for distribution by single-bill customers, e.g., apartments or private employers.
☐ Deliver the report to community organizations.
☒ Other: At city hall as well

Send to EGLE a copy of the news articles, a list of channels broadcast and dates, and a list of locations/organizations reports delivered to and dates.

A Tier 3 Public Notice is Distributed with this CCR

☐ This CCR is being used to deliver a Tier 3 Public Notice for one or more violations. To use this Tier 3 delivery option, the CCR must be directly delivered to each bill paying customer or, with EGLE approval, continuously posted, and must be issued within 12 months of learning of the violation. A copy of this form must be delivered to the EGLE within ten days of delivering the CCR to customers to meet the public notification requirements.

Name/Title: Tommy Simpson / City Manager

Signature: _____ Date: 6/27/22

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
DRINKING WATER AND ENVIRONMENTAL HEALTH DIVISION

EGLE

CONSUMER CONFIDENCE REPORT CHECKLIST

Water System: City of Bangor CCR Calendar Year: 2021

Missing	Inadeq.	Adeq.	N/A	
				WATER SYSTEM INFORMATION
☐	☐	☒	☐	Name and phone number of contact person
☐	☐	☒	☐	Information on public participation opportunities
☐	☐	☐	☐	Information for non-English speaking populations (if applicable)
				SOURCES OF WATER
☐	☐	☒	☐	Type, name, and location of bodies of water used as sources
☐	☐	☒	☐	Availability and how to obtain information from Source Water Assessment, brief summary of susceptibility
				REQUIRED EDUCATIONAL INFORMATION
☐	☐	☒	☐	"The sources of drinking water, both tap water and bottled water, include...
☐	☐	☒	☐	"Contaminants that may be present in source water include all of the...
☐	☐	☒	☐	"To ensure that tap water is safe to drink, EPA prescribes...
☐	☐	☒	☐	"Drinking water, including bottled water, may reasonably be expected...
☐	☐	☒	☐	"Some people may be more vulnerable to contaminants..."
☐	☐	☒	☐	Informational statement about lead: "If present, elevated levels of lead…"
☐	☐	☐	☒	Informational statements on arsenic and nitrate (if applicable)
☐	☐	☐	☒	Informational statements about Level 1 Assessment or Level 2 Assessment (if applicable)
☐	☐	☒	☐	Informational statements for vulnerable sub-populations on the following contaminants if detected over the level of concern: lead, copper, nitrate, fluoride, fecal coliform, or E. coli. See R 325.10420 (Rule 420).
				DEFINITIONS
☐	☐	☒	☐	Maximum Contaminant Level (MCL) / Maximum Contaminant Level Goarl (MCLG)
☐	☐	☒	☐	Maximum Residual Disinfectant Level (MRDL) / Maximum Residual Disinfectant Level Goal (MRDLG)

2021 Water Quality Report for the CITY OF BANGOR

Consumer confidence Report on the quality of our tap water. Water Supply Serial Number: 0380

This report covers the drinking water quality for City of Bangor for the 2021 calendar year. This information is a snapshot of the quality of the water that we provided to you in 2021. Included are details about where your water comes from, what it contains, and how it compares to United States Environmental Protection Agency (USEPA) and state standards.

Your water comes from four groundwater wells, each over ranging 64 to 219 feet deep. The State performed an assessment of our source water to determine the susceptibility or the relative potential of contamination. The susceptibility rating is on a seven-tiered scale from "very-low" to "very-high" based on geologic sensitivity, well construction, water chemistry and contamination sources. The susceptibility of our source is HIGHLY SUSCEPTIBLE.

There are significant sources of contamination include OLD ABANDON WELLS, OLD FUEL TANKS, AND OLD INDUSTRIES SITES in our water supply. We are making efforts to protect our sources by SECURING MONIES TO CAP OFF OLD WELLS AND WE HAVE COMPLETED A WELLHEAD PROTECTION PROGRAM.

If you would like to know more about this report, please contact: CITY MANAGER TOMMY SIMPSON 427-5831, OR STEVEN LOWDER WATER DEPARTMENT SUPERVISOR 312-4298.

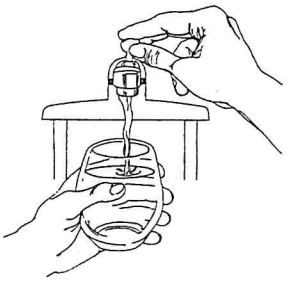
Contaminants and their presence in water: Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the USEPA's Safe Drinking Water Hotline (800-426-4791).

Vulnerability of sub-populations: Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune systems disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. USEPA/Center for Disease Control guidelines on appropriate means to lessen the risk of infection by Cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (800-426-4791).

Sources of drinking water: The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. Our water comes from wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Contaminants that may be present in source water include:

- **Microbial contaminants**, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
- **Inorganic contaminants**, such as salts and metals, which can be naturally occurring or result from urban stormwater runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.
- **Pesticides and herbicides**, which may come from a variety of sources such as agriculture and residential uses.
- **Radioactive contaminants**, which can be naturally occurring or be the result of oil and gas production and mining activities.
- **Organic chemical contaminants**, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, and septic systems.



To ensure that tap water is safe to drink, the USEPA prescribes regulations that limit the levels of certain contaminants in water provided by public water systems. Federal Food and Drug Administration regulations establish limits for contaminants in bottled water which provide the same protection for public health.

Water Quality Data

The table below lists all the drinking water contaminants that we detected during the 2021 calendar year. The presence of these contaminants in the water does not necessarily indicate that the water poses a health risk. Unless otherwise noted, the data presented in this table is from testing done January 1 through December 31, 2021. The State allows us to monitor for certain contaminants less than once per year because the concentrations of these contaminants are not expected to vary significantly from year to year. All the data is representative of the water quality, but some are more than one year old.

Terms and abbreviations used below:

- Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
- Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.
- Maximum Residual Disinfectant Level (MRDL): The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- Maximum Residual Disinfectant Level Goal (MRDLG): The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- Treatment Technique (TT): A required process intended to reduce the level of a contaminant in drinking water.
- N/A: Not applicable
- ND: not detectable at testing limit
- ppm: parts per million or milligrams per liter
- ppb: parts per billion or micrograms per liter
- ppt: parts per trillion or nanograms per liter
- Action Level (AL): The concentration of a contaminant which, if exceeded, triggers treatment or other requirements that a water system must follow.
- Level 1 Assessment: A study of the water supply to identify potential problems and determine (if possible) why total coliform bacteria have been found in our water system.
- Level 2 Assessment: A very detailed study of the water system to identify potential problems and determine (if possible) why an *E. coli* MCL violation has occurred and/or why total coliform bacteria have been found in our water system on multiple occasions.

1Monitoring Data for Regulated Contaminants

Regulated Contaminant	MCL, TT, or MRDL	MCLG or MRDLG	Level Detected	Range	Year Sampled	Violation Yes/No	Typical Source of Contaminant
Arsenic (ppb)	10	0	4.3 ppb	3.6 to 4.3	8/31/21	no	Erosion of natural deposits; Runoff from orchards; Runoff from glass and electronics production wastes
Barium (ppm)	2	2	.098 ppm	.011 to .098	8/31/21	no	Discharge of drilling wastes; Discharge of metal refineries; Erosion of natural deposits
Nitrate (ppm)	10	10	ND	ND	8/31/21	no	Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits
Fluoride (ppm)	4	4	1.1 ppm	ND to 1.1 ppm	8/31/21	no	Erosion of natural deposits; Water additive which promotes strong teeth; Discharge from fertilizer and aluminum factories
Sodium[1] (ppm)	N/A	N/A	14 ppm	8.5 to 14 ppm	8/31/21	no	Erosion of natural deposits
TTHM Total Trihalomethanes (ppb)	80	N/A	25 ppb	25	8/31/21	no	Byproduct of drinking water disinfection
HAA5 Haloacetic Acids (ppb)	60	N/A	5.64 ppb	5.64 ppb	8/31/21	no	Byproduct of drinking water disinfection
Chlorine[2] (ppm)	4	4	1.41 ppm	.555 to .618	1/1/21 to 12/31/21	no	Water additive used to control microbes
Total Coliform (total number or % of positive samples/month)	TT	N/A	0	N/A		no	Naturally present in the environment
E. coli in the distribution system (positive samples)	See *E. coli* note[3]	0	0	N/A		no	Human and animal fecal waste
Fecal Indicator – *E. coli* at the source (positive samples)	TT	N/A	0	N/A		no	Human and animal fecal waste

[1] Sodium is not a regulated contaminant.

[2] The chlorine "Level Detected" was calculated using a running annual average.

Per- and polyfluoroalkyl substances (PFAS)							
Regulated Contaminant	MCL, TT, or MRDL	MCLG or MRDLG	Level Detected	Range	Year Sampled	Violation Yes/No	Typical Source of Contaminant
Hexafluoropropylene oxide dimer acid (HFPO-DA) (ppt)	370	N/A	< 2	< 2	8/31/21	no	Discharge and waste from industrial facilities utilizing the Gen X chemical process
Perfluorobutane sulfonic acid (PFBS) (ppt)	420	N/A	< 2	< 2	8/31/21	no	Discharge and waste from industrial facilities; Stain-resistant treatments
Perfluorohexane sulfonic acid (PFHxS) (ppt)	51	N/A	< 2	< 2	8/31/21	no	Firefighting foam; Discharge and waste from industrial facilities
Perfluorohexanoic acid (PFHxA) (ppt)	400,000	N/A	< 2	< 2	8/31/21	no	Firefighting foam; Discharge and waste from industrial facilities
Perfluorononanoic acid (PFNA) (ppt)	6	N/A	< 2	< 2	8/31/21	no	Discharge and waste from industrial facilities; Breakdown of precursor compounds
Perfluorooctane sulfonic acid (PFOS) (ppt)	16	N/A	< 2	< 2	8/31/21	no	Firefighting foam; Discharge from electroplating facilities; Discharge and waste from industrial facilities
Perfluorooctanoic acid (PFOA) (ppt)	8	N/A	< 2	< 2	8/31/21	no	Discharge and waste from industrial facilities; Stain-resistant treatments
Inorganic Contaminant Subject to ALs	AL	MCLG	Your Water[4]	Range of Results	Year Sampled	Number of Samples Above AL	Typical Source of Contaminant
Lead (ppb)	15 ppb	0	5 ppb	ND to 5	6/9/20		Lead service lines, corrosion of household plumbing including fittings and fixtures; Erosion of natural deposits
Copper (ppm)	1.3 ppm	1.3	0.53 ppm	ND to 0.53	6/9/20		Corrosion of household plumbing systems; Erosion of natural deposits

[3] *E. coli* MCL violation occurs if: (1) routine and repeat samples are total coliform-positive and either is *E. coli*-positive, or (2) the supply fails to take all required repeat samples following *E. coli*-positive routine sample, or (3) the supply fails to analyze total coliform-positive repeat sample for *E. coli*.

[4] Ninety (90) percent of the samples collected were at or below the level reported for our water.

EGLE found a deficiency in our 2020 CCR report that this statement on Lead and Copper was excluded. The 90th percentile values for lead should be 2 parts per billion (ppb), and the 90th percentile for copper should be 0.3 parts per million (ppm). Also the action level (AL) for lead should be listed as 15 ppb, and the AL for copper should be 1.3 ppm.

Additional Monitoring

Unregulated contaminants are those for which the USEPA has not established drinking water standards. Monitoring helps the USEPA determine where certain contaminants occur and whether regulation of those contaminants is needed.

Unregulated Contaminant Name	Average Level Detected	Range	Year Sampled	Comments
[Name of Unregulated Contaminant] (unit)				Results of monitoring are available upon request
[Name of Unregulated Contaminant] (unit)				Results of monitoring are available upon request

Information about lead: If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. The City of Bangor is responsible for providing high quality drinking water but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you have a lead service line, it is recommended that you run your water for at least 5 minutes to flush water from both your home plumbing and the lead service line. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the USEPA's Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

Infants and children who drink water containing lead could experience delays in their physical or mental development. Children could show slight deficits in attention span and learning abilities. Adults who drink this water over many years could develop kidney problems or high blood pressure.

Copper is an essential nutrient, but some people who drink water containing copper in excess of the action level over a relatively short amount of time could experience gastrointestinal distress. Some people who drink water containing copper in excess of the action level over many years could suffer liver or kidney damage. People with Wilson's Disease should consult their personal doctor.

Our water supply has estimated 450 lead service lines and estimated 230 service lines of unknown material out of a total of 1350 service lines with 400 disconnected lines over the years at the main or the shut off.

Monitoring and Reporting to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Requirements: The State of Michigan and the USEPA require us to test our water on a regular basis to ensure its safety. We use Paw Paw Lab for bacti samples and Trace Lab for the yearly samples. We met all the monitoring and reporting requirements for 2021.

We will update this report annually and will keep you informed of any problems that may occur throughout the year as they happen. Copies are available at City Hall 257 West Monroe Street and Public Works 421 West Arlington Street. This report can be found on the City of Bangor website and will be in the Van Buren Reminder. This report will not be sent to you.

We invite public participation in decisions that affect drinking water quality. The council meets the first and third Monday of each month at 7:00 pm in the council chambers. For more information about your water or the contents of this report, contact Tommy Simpson city manager 269-427-5831 or Steven Lowder water operator 269-312-4298. For more information about safe drinking water, visit the USEPA at http://www.epa.gov/safewater.

2023 Water Quality Report for CITY of BANGOR

Water Supply Serial Number: 0380 WSSN

This report covers the drinking water quality for the City of Bangor for the 2023 calendar year. This information is a snapshot of the quality of the water that we provided to you in 2023. Included are details about where your water comes from, what it contains, and how it compares to United States Environmental Protection Agency (U.S. EPA) and state standards.

Your water comes from wells 3,7,8, and 9 groundwater wells, each over 70 to 219 feet deep. The State performed an assessment of our source water to determine the susceptibility or the relative potential of contamination. The susceptibility rating is on a seven-tiered scale from "very-low" to "very-high" based on geologic sensitivity, well construction, water chemistry and contamination sources. The susceptibility of our source is HIGHLY SUSCEPTIBLE.

There are significant sources of contamination which include old abandon wells, old fuel tanks, and old industrial sites in our water supply. We are making efforts to protect our sources by securing monies to continue to cap of old wells, clean up sites, and update / restart our wellhead protection program.

If you would like to know more about this report, please contact: City Manager Justin Weber 269-427-5831 or Steven Lowder Director / Operator 269-312-4298.

Contaminants and their presence in water: Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the U.S. EPA's Safe Drinking Water Hotline (800-426-4791).

Vulnerability of sub-populations: Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune systems disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. U.S. EPA/Center for Disease Control guidelines on appropriate means to lessen the risk of infection by Cryptosporidium and other microbial contaminants are available from the Safe Drinking Water Hotline (800-426-4791).

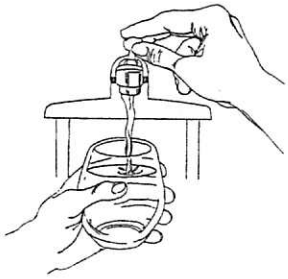
Sources of drinking water: The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. Our water comes from wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity.

Contaminants that may be present in source water include:

- **Microbial contaminants**, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations and wildlife.
- **Inorganic contaminants**, such as salts and metals, can be naturally occurring or result from urban stormwater runoff, industrial or

domestic wastewater discharges, oil and gas production, mining or farming.

- **Pesticides and herbicides**, which may come from a variety of sources such as agriculture and residential uses.
- **Radioactive contaminants**, which can be naturally occurring or be the result of oil and gas production and mining activities.
- **Organic chemical contaminants**, including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, and septic systems.



In order to ensure that tap water is safe to drink, the U.S. EPA prescribes regulations that limit the levels of certain contaminants in water provided by public water systems. Federal Food and Drug Administration regulations establish limits for contaminants in bottled water which provide the same protection for public health.

Water Quality Data

The table below lists all the drinking water contaminants that we detected during the 2023 calendar year. The presence of these contaminants in the water does not necessarily indicate that the water poses a health risk. Unless otherwise noted, the data presented in this table is from testing done January 1 through December 31, 2023. The State allows us to monitor for certain contaminants less than once per year because the concentrations of these contaminants are not expected to vary significantly from year to year. All the data is representative of the water quality, but some are more than one year old.

Terms and abbreviations used below:

- Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.
- Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.
- Maximum Residual Disinfectant Level (MRDL): The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.
- Maximum Residual Disinfectant Level Goal (MRDLG): The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.
- Treatment Technique (TT): A required process intended to reduce the level of a contaminant in drinking water.
- N/A: Not applicable
- ND: not detectable at testing limit
- ppm: parts per million or milligrams per liter
- ppb: parts per billion or micrograms per liter
- ppt: parts per trillion or nanograms per liter

- pCi/l: picocuries per liter (a measure of radioactivity)
- Action Level (AL): The concentration of a contaminant which, if exceeded, triggers treatment or other requirements that a water system must follow.
- Level 1 Assessment: A study of the water supply to identify potential problems and determine (if possible) why total coliform bacteria have been found in our water system.
- Level 2 Assessment: A very detailed study of the water system to identify potential problems and determine (if possible) why an *E. coli* MCL violation has occurred and/or why total coliform bacteria have been found in our water system on multiple occasions.

1Monitoring Data for Regulated Contaminants

Regulated Contaminant	MCL, TT, or MRDL	MCLG or MRDLG	Level Detected	Range	Year Sampled	Violation Yes/No	Typical Source of Contaminant
Arsenic (ppb)	10	0	6.4 ppb	5.7 to 6.4	2023	no	Erosion of natural deposits; Runoff from orchards; Runoff from glass and electronics production wastes
Barium (ppm)	2	2	.098 ppm	.011 to .098	2021	no	Discharge of drilling wastes; Discharge of metal refineries; Erosion of natural deposits
Nitrate (ppm)	10	10	ND	ND	2023	no	Runoff from fertilizer use; Leaching from septic tanks, sewage; Erosion of natural deposits
Fluoride (ppm)	4	4	.89 ppm	.17 to .89	2023	no	Erosion of natural deposits; Water additive which promotes strong teeth; Discharge from fertilizer and aluminum factories
Sodium[1] (ppm)	N/A	N/A	14 ppm	8.5 to 14 ppm	2021	no	Erosion of natural deposits
TTHM Total Trihalomethanes (ppb)	80	N/A	ND	ND	2023	no	Byproduct of drinking water disinfection
HAA5 Haloacetic Acids (ppb)	60	N/A	ND	ND	2023	no	Byproduct of drinking water disinfection
Chlorine[2] (ppm)	4	4	5.85 ppm	3.02 to 5.85	2023	no	Water additive used to control microbes
Alpha emitters (pCi/L)	15	0	2.25pCi/L	.546 to 2.25pCi/L	2022	no	Erosion of natural deposits
Combined radium (pCi/L)	5	0	.522 pCi/L	0 to .522 pCi/L	2022	no	Erosion of natural deposits
Total Coliform	TT	N/A	N/A	N/A	N/A	N/A	Naturally present in the environment
E. coli in the distribution system (positive samples)	See E. coli note[3]	0	0	N/A	2023	no	Human and animal fecal waste
Fecal Indicator – E. coli at the source (positive samples)	TT	N/A	0	N/A	2023	no	Human and animal fecal waste

[1] Sodium is not a regulated contaminant.

[2] The chlorine "Level Detected" was calculated using a running annual average.

[3] *E. coli* MCL violation occurs if: (1) routine and repeat samples are total coliform-positive and either is *E. coli*-positive, or (2) the supply fails to take all required repeat samples following *E. coli*-positive routine sample, or (3) the supply fails to analyze total coliform-positive repeat sample for *E. coli*.

4 Ninety (90) percent of the lead and copper samples collected were at or below the level reported for our water.

If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. The City of Bangor is responsible for providing high quality drinking water but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you have a lead service line it is recommended that you run your water for at least 5 minutes to flush water from both your home plumbing and the lead service line. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline at 1-800-426-4791 or at http://www.epa.gov/safewater/lead.

Per- and polyfluoroalkyl substances (PFAS)							
Regulated Contaminant	MCL, TT, or MRDL	MCLG or MRDLG	Level Detected	Range	Year Sampled	Violation Yes/No	Typical Source of Contaminant
Hexafluoropropylene oxide dimer acid (HFPO-DA) (ppt)	370	N/A	123 ppt	113 to 123 ppt	2022	no	Discharge and waste from industrial facilities utilizing the Gen X chemical process
Perfluorobutane sulfonic acid (PFBS) (ppt)	420	N/A	< 2 ppt	< 2 ppt	2023	no	Discharge and waste from industrial facilities; stain-resistant treatments
Perfluorohexane sulfonic acid (PFHxS) (ppt)	51	N/A	< 2 ppt	< 2 ppt	2023	no	Firefighting foam; discharge and waste from industrial facilities
Perfluorohexanoic acid (PFHxA) (ppt)	400,000	N/A	< 2 ppt	< 2 ppt	2023	no	Firefighting foam; discharge and waste from industrial facilities
Perfluorononanoic acid (PFNA) (ppt)	6	N/A	< 2 ppt	< 2 ppt	2023	no	Discharge and waste from industrial facilities; breakdown of precursor compounds
Perfluorooctane sulfonic acid (PFOS) (ppt)	16	N/A	< 2 ppt	< 2 ppt	2023	no	Firefighting foam; discharge from electroplating facilities; discharge and waste from industrial facilities
Perfluorooctanoic acid (PFOA) (ppt)	8	N/A	< 2 ppt	< 2 ppt	2023	no	Discharge and waste from industrial facilities; stain-resistant treatments
Inorganic Contaminant Subject to Action Levels (AL)	Action Level	MCLG	Your Water[4]	Range of Results	Year Sampled	Number of Samples Above AL	Typical Source of Contaminant
Lead (ppb)	15	0	1 ppb	0 to 1 ppb	2023	0	Lead service lines, corrosion of household plumbing including fittings and fixtures; Erosion of natural deposits
Copper (ppm)	1.3	1.3	0.096 ppm	0.0 to 0.4	2023	0	Corrosion of household plumbing systems; Erosion of natural deposits

Information about lead: If present, elevated levels of lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. The City of Bangor is responsible for providing high quality drinking water but cannot control the variety of materials used in plumbing components. When your water has been sitting for several hours, you can minimize the potential for lead exposure by flushing your tap for 30 seconds to 2 minutes before using water for drinking or cooking. If you have a lead service line it is recommended that you run your water for at least 5 minutes to flush water from both your home plumbing and the lead service line. If you are concerned about lead in your water, you may wish to have your water tested. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available from the Safe Drinking Water Hotline or at http://www.epa.gov/safewater/lead.

Infants and children who drink water containing lead could experience delays in their physical or mental development. Children could show slight deficits in attention span and learning abilities. Adults who drink this water over many years could develop kidney problems or high blood pressure.

Copper is an essential nutrient, but some people who drink water containing copper in excess of the action level over a relatively short amount of time could experience gastrointestinal distress. Some people who drink water containing copper more than the action level over many years could suffer liver or kidney damage. People with Wilson's Disease should consult their personal doctor.

Our water supply has 700 lead service lines and 250 service lines of unknown material out of a total of 1350 service lines with about 400 shut odd or disconnected at the main.

Monitoring and Reporting to the Department of Environment, Great Lakes, and Energy (EGLE) Requirements: The State of Michigan and the U.S. EPA require us to test our water on a regular basis to ensure its safety. We use Paw Paw Labs and Trace Labs for our testing and also South Haven City as a backup if needed. We met all the monitoring and reporting requirements for 2023.

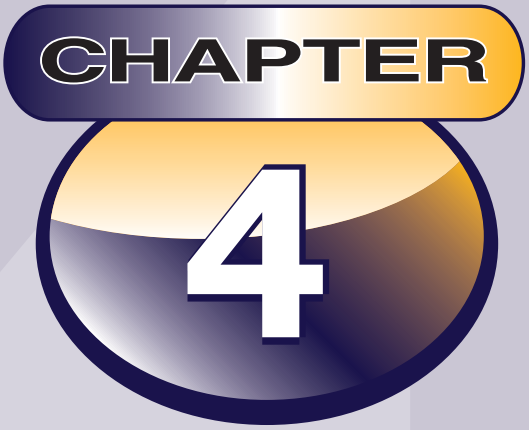
We will update this report annually and will keep you informed of any problems that may occur throughout the year, as they happen. Copies are available at City Hall 257 West Monroe and Public Works 421 West Arlington Street. This report is also on the city's webpage. This report will not be sent to you.

We invite public participation in decisions that affect drinking water quality. The council meets the first and third Monday's at 7 pm in the council chambers at 257 West Monroe Street. For more information about your water, or the contents of this report, contact Steven Lowder Operator at 269-312-4298. Our website bangormi.org. For more information about safe drinking water, visit the U.S. EPA at http://www.epa.gov/safewater.

We will update this report annually and will keep you informed of any problems that may occur throughout the year, as they happen. Copies are available at Bangor City Hall 257 W. Monroe Street or Public Works 421 W. Arlington Street, also on our city website at cityofbangormi.org. This report will be published in the Van Buren Reminder. Be advised this report will not be sent to you.

We invite public participation in decisions that affect drinking water quality. The council meets on the first and third Mondays of the month at 7 pm at the council chambers on 257 W. Monroe Street. For more information on your water, or the contents of this report, contact Justin Weber, City Manager at 269-427-5831 or Steven Lowder, Operator, at 269-312-4298. For more information about safe drinking water, visit the U.S. EPA at http://epa.gov/safewater.

Appendix B
Population Projections Sources


CHAPTER
4

Population Vitality Overview

The Population Vitality section covers information on total population, migration, age, household size, and race. In particular, the Population Vitality section examines the following indicators:

4.1.1 Historical County and Municipal Total Population, 1950-2010

4.1.2. County Comparison Bar Charts of % Population Change, 2000-2010

4.2.1 Maps of County In-Migration and Out-Migration, 2005-2009

4.2.2 Detailed County Distributions of Net Migration by Age, Education, and Income Categories, 2006-2010

4.2.3 County Comparison Bar Charts of Net Migration by Age, Education, and Income Categories, 2006-2010

4.2.4 County Net Migration Line Charts, 2001-2009

4.2.5 Map of Net Intercounty Domestic Migration of Individuals with Bachelor's Degrees or Higher in Southwest Michigan, 2006-2010

4.2.6 Map of Net Total Intercounty Domestic Migration, in Southwest Michigan, 2006-2010.

4.3.1 Population of the 3 Counties and US Population Proportions by Age and Sex, 2000 and 2010

4.3.2 County Comparisons of Age Groups, 2010.

4.3.3 Map of Median Age by Census Tract, 2010

4.4.1 County Comparisons of Average Household Size, 2006-2010

4.4.2 Historical Average Household Size, 1970-2010

4.4.3 Map of Average Household Size, by Census Tract, 2010

4.5.1 County Comparisons of Racial Composition, 2010

4.5.2 County Comparisons of Racial Residential Dissimilarity Indices, 2010

Total Population Overview

Between 2000 and 2010, Berrien County lost population at the second-highest rate of any of its twenty comparison counties. Van Buren County saw a small decrease in population, while Cass County actually gained population over that time.

From 1950 to 2010, Berrien, Cass, and Van Buren Counties have all experienced an increase in the share of their population living in townships, and a decline in the share of their population living in cities and villages.

Migration Overview

Between 2000 and 2010, Berrien and Cass Counties both experienced high net losses of their population ages 25-34, relative to their comparison counties. Berrien and Cass Counties also experienced net losses of their populations that had attained bachelor's or degrees or higher and populations making more than $50,000 per year. In contrast, Van Buren County experienced net gains among all three of these populations.

In an average year between 2005 and 2009, the vast majority of tax-filers who entered one of the three counties in the Southwest Michigan region previously filed taxes in another county in Southwest Michigan, or in counties within the Detroit, Michiana and Chicago regions. Similarly, the vast majority of tax-filers who left the three-county region filed their taxes in another county in Southwest Michigan, or in counties within the Detroit, Michiana or Chicago regions.

Age

Of the three counties, Van Buren County has the highest percentage of its population that is under the age of 18, and this percentage is higher than the figure for the entire United States. All three counties have lower percentages of their population that are between the ages of 25 and 44 than for the United States as whole. In contrast, all three counties have a percentage of their population aged 65 and older that is higher than that of the nation, with Berrien County having the highest percentage of elderly residents in the region.

Household Size

Berrien County has the smallest average household size in the three-county region. This average household size is consistent with Berrien County having a lower percentage of its households in families than either Cass or Van Buren County. Cass and Van Buren County each have a percentage of households in families higher than that of the United States. In addition, Berrien County has a greater percentage of single-person households than the United States as a whole and either of the two other counties.

Each county has experienced a declining household size in 1970, and this trend continued for all three counties between 2000 and 2010.

Race

All three counties have a higher percentage of their population that identifies as White, and a lower percentage that identifies as Hispanic/Latino, than the United States as a whole. Berrien County has a higher percentage that identifies as Black than the nation as a whole, while Cass and Van Buren have lower percentages.

The dissimilarity index measures the level of residential racial segregation between groups. A higher index value indicates a greater degree of segregation. For all three counties, the White/Hispanic dissimilarity index is lower than the index for the Black Population comparisons, indicating that Whites and Hispanics are less residentially segregated from each other than Blacks are from these groups. Berrien County has the highest Black/White and Black/Hispanic dissimilarity index of any county in its comparison group.

Total Population Detailed Indicators

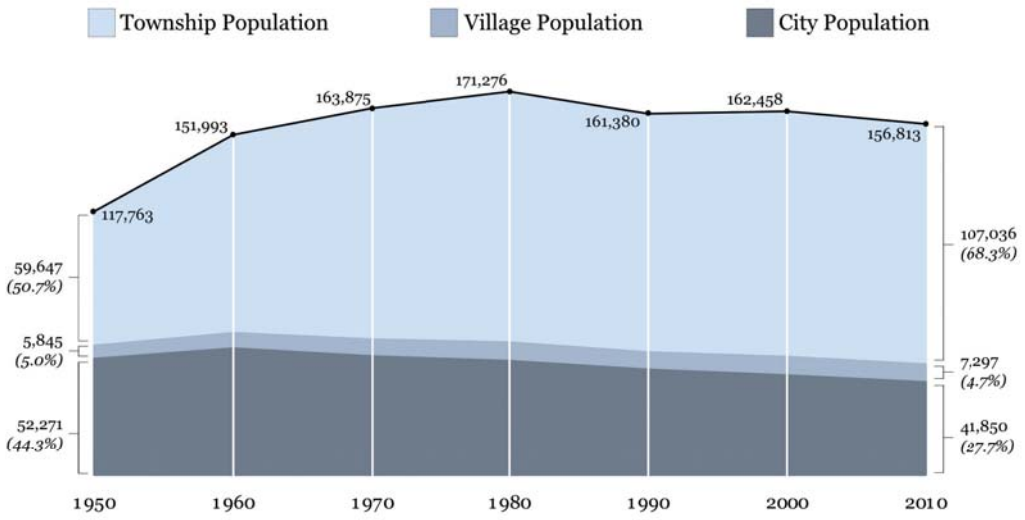
4.1.1 Historical County and Municipal Population 1950-2010

This indicator illustrates long-term trends in the size of the population and its distribution throughout each county in the region. While all three counties have seen an absolute increase in population as compared with 1950, all three have experienced a continuous shift of that population away from the region's cities and villages and into townships. Between 1950 and 2010, the share of the total regional population that lived in townships increased by 18.8%. During the same time, the share that lives in cities decreased by 16.0%.

During the decade between 2000 and 2010, Berrien County also experienced a decrease in township population, consistent with a decline in total county population over that time.

http://www.swmpc.org/downloads/411.xls

Figure 4.1.1: Berrien County Population, 1950-2010

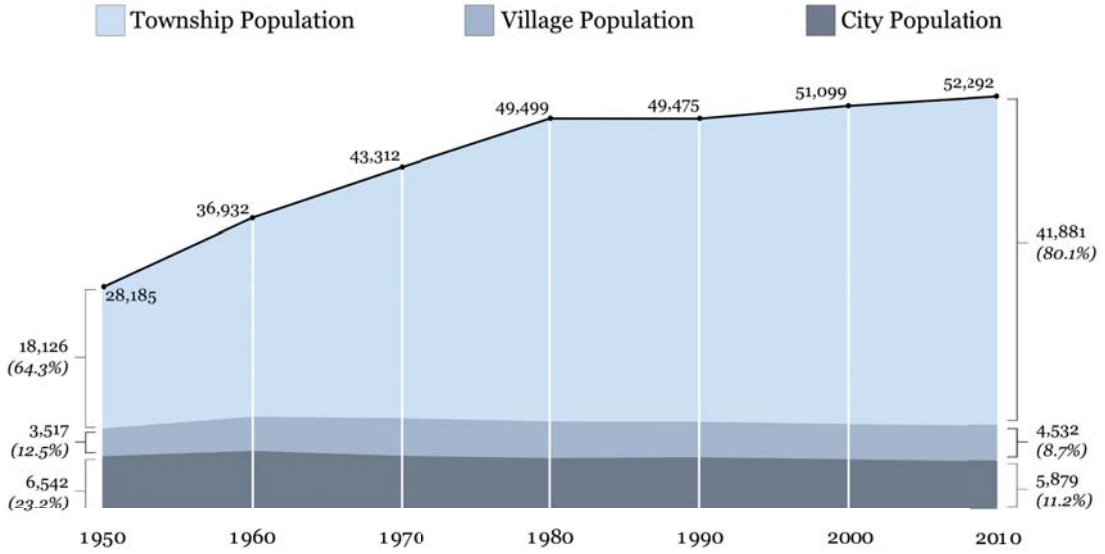


City Name	1950 Pop	1950-2010 Pop Trend	2010 Pop	2000 - 2010 Pop Change
Benton Harbor	18,769		10,038	-10.2%
Bridgman	977		2,291	-5.6%
Buchanan	5,224		4,456	-4.8%
Coloma	1,041		1,483	-7.0%
New Buffalo	1,565		1,883	-14.4%
Niles	13,145		11,599	-5.0%
St. Joseph	10,223		8,365	-4.8%
Watervliet	1,327		1,735	-5.9%

Village Name	1950 Pop	1950-2010 Pop Trend	2010 Pop	2000 - 2010 Pop Change
Baroda	344		873	1.7%
Berrien Springs	1,761		1,800	-3.3%
Eau Claire	480		625	-4.7%
Galien	610		549	-7.4%
Grand Beach	105		272	23.1%
Michiana	102		182	-9.0%
Shoreham	391		862	0.2%
Stevensville	480		1,142	-4.1%
Three Oaks	1,572		1,622	-11.3%

Township Name	1950 Pop	1950-2010 Pop Trend	2010 Pop	2000 - 2010 Pop Change
Bainbridge	2,194		2,850	-9.0%
Baroda	1,558		2,801	-2.7%
Benton Charter	15,171		14,749	-10.1%
Berrien	2,542		5,084	0.2%
Bertrand	1,342		2,657	11.6%
Buchanan	1,655		3,523	0.4%
Chikaming	2,318		3,100	-15.7%
Coloma Charter	2,267		5,020	-3.8%
Galien	1,380		1,452	-9.9%
Hagar	2,451		3,671	-7.4%
Lake Charter	1,928		2,972	-5.6%
Lincoln Charter	2,588		14,691	5.3%
Niles Charter	5,732		14,164	6.3%
New Buffalo	2,879		2,386	-3.3%
Oronoko Charter	4,737		9,193	-6.6%
Pipestone	1,911		2,312	-6.5%
Royalton	1,414		4,766	22.6%
Sodus	2,092		1,932	-9.7%
St. Joseph Charter	3,238		10,028	-0.1%
Three Oaks	2,469		2,574	-12.7%
Watervliet	1,715		3,102	-8.5%
Weesaw	1,911		1,936	-6.2%

Figure 4.1.1: Cass County Population, 1950-2010

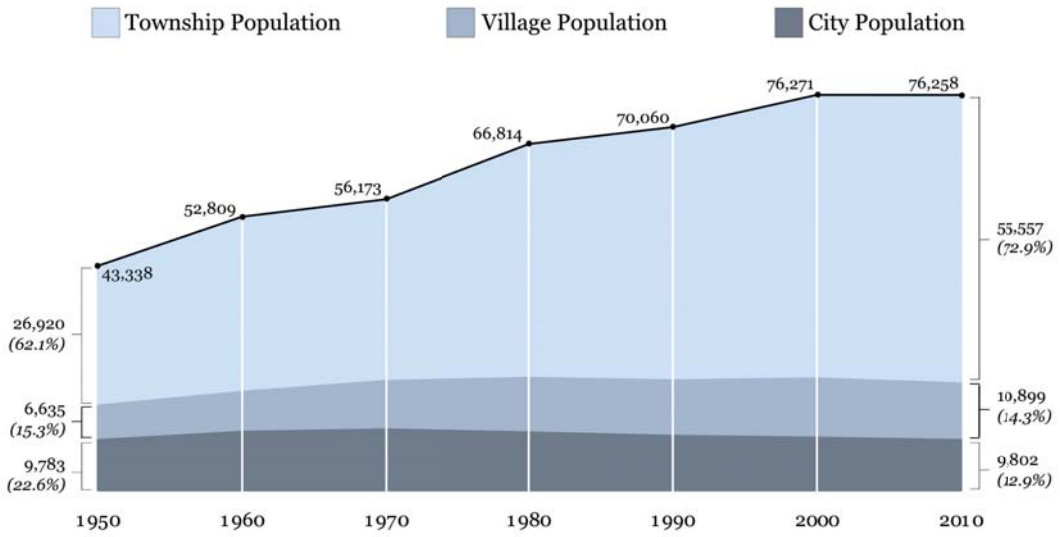


City Name	1950 Pop	1950-2010 Pop Trend	2010 Pop	2000 - 2010 Pop Change
Dowagiac	6,542		5,879	-4.4%

Village Name	1950 Pop	1950-2010 Pop Trend	2010 Pop	2000 - 2010 Pop Change
Cassopolis	1,527		1,774	2.0%
Edwardsburg	616		1,259	9.8%
Marcellus	1,014		1,198	3.1%
Vandalia	360		301	-29.8%

Township Name	1950 Pop	1950-2010 Pop Trend	2010 Pop	2000 - 2010 Pop Change
Calvin	996		2,037	-0.2%
Howard	2,952		6,207	-1.6%
Jefferson	987		2,541	5.8%
La Grange	2,488		3,500	4.8%
Marcellus	1,621		2,539	-6.4%
Mason	590		2,945	17.1%
Milton	1,179		3,878	46.6%
Newberg	907		1,632	-4.2%
Ontwa	2,020		6,549	11.7%
Penn	1,164		1,774	-6.7%
Pokagon	1,518		2,029	-7.7%
Porter	1,402		3,798	0.1%
Silver Creek	1,173		3,218	-7.8%
Volinia	774		3,218	-5.3%
Wayne	1,272		2,654	-7.2%

Figure 4.1.1: Van Buren County Population, 1950-2010



City Name	1950 Pop	1950-2010 Pop Trend	2010 Pop	2000 - 2010 Pop Change
Bangor	1,694		1,885	-2.5%
Gobles	622		829	1.7%
Hartford	1,838		2,688	8.6%
South Haven	5,629		4,400	-12.4%

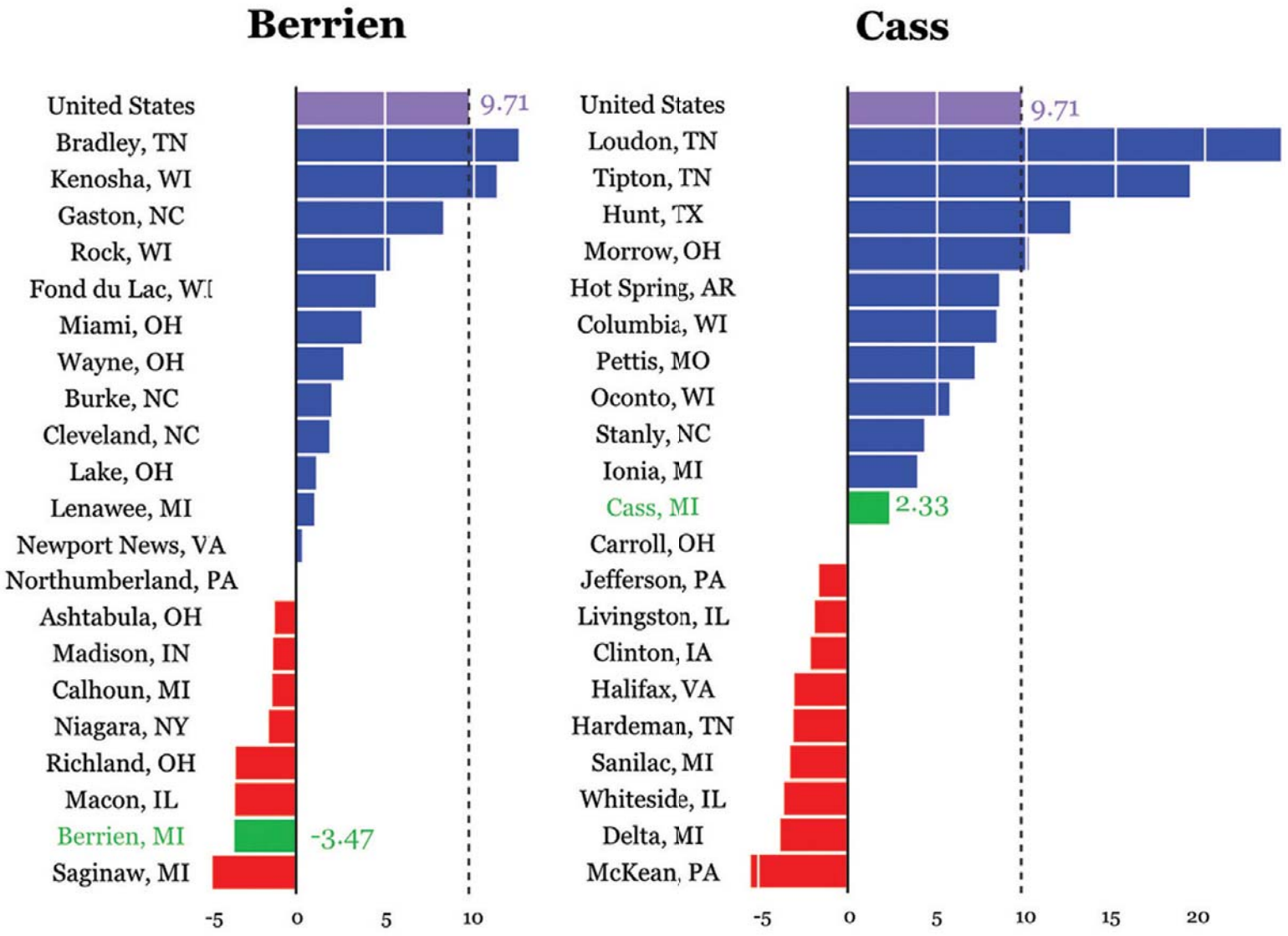
Village Name	1950 Pop	1950-2010 Pop Trend	2010 Pop	2000 - 2010 Pop Change
Bloomingdale	465		454	-14.0%
Breedsville	239		199	-15.3%
Decatur	1,664		1,819	-1.0%
Lawrence	679		996	-5.9%
Lawton	1,206		1,900	2.2%
Mattawan	NA		1,997	-21.3%
Paw Paw	2,382		3,534	5.1%

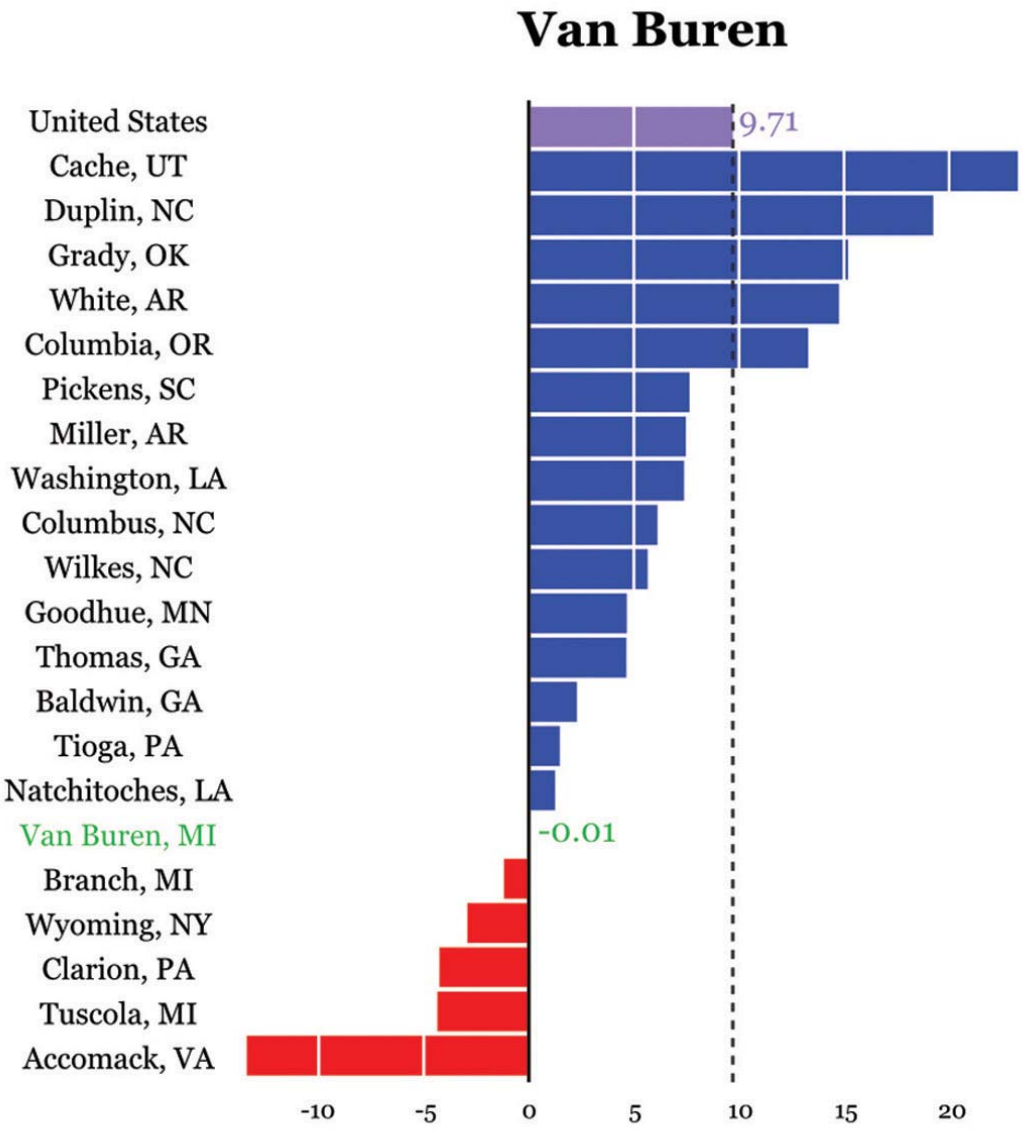
Township Name	1950 Pop	1950-2010 Pop Trend	2010 Pop	2000 - 2010 Pop Change
Almena	1,014		4,992	18.1%
Antwerp	2,976		12,182	12.7%
Arlington	1,383		2,073	-0.1%
Bangor	2,572		2,147	1.2%
Bloomingdale	1,866		3,103	-7.8%
Columbia	1,432		2,588	-4.6%
Covert	1,734		2,888	-8.1%
Decatur	2,756		3,726	-4.9%
Geneva	1,492		3,573	-10.1%
Hamilton	898		1,489	-17.1%
Hartford	3,256		3,274	3.6%
Keeler	1,414		2,169	-16.6%
Lawrence	1,799		3,259	-2.5%
Paw Paw	3,726		7,041	-0.7%
Pine Grove	1,593		2,949	6.3%
Porter	845		2,466	2.5%
South Haven Charter	1,885		3,983	-1.6%
Waverly	914		2,554	3.5%

4.1.2 County Comparison of Population Change %, 2000-2010

This indicator measures relative population growth over the decade 2000-2010 through percent change. Counties with blue bars gained population over the decade, while those counties with red bars lost population. Berrien County experienced the second highest percentage decline in population within its comparison group, and Van Buren County also experienced a slight decrease in population over the decade. Yet the graphic also shows that population decline was not uniform throughout the region. Cass County actually gained population during the decade.

http://www.swmpc.org/downloads/412.xls




Van Buren
United States
Cache, UT
Duplin, NC
Grady, OK
White, AR
Columbia, OR
Pickens, SC
Miller, AR
Washington, LA
Columbus, NC
Wilkes, NC
Goodhue, MN
Thomas, GA
Baldwin, GA
Tioga, PA
Natchitoches, LA
Van Buren, MI
Branch, MI
Wyoming, NY
Clarion, PA
Tuscola, MI
Accomack, VA
9.71
-0.01
-10
-5
0
5
10
15
20

Population and Household Trends Introduction

Predictions of the future economic health of Southwest Michigan can be strongly informed by the historic population growth patterns of the region and the current population profile. Through the understanding of current trends, this strategy can better prepare decision-makers for regional changes in population age, location, and household makeup. Improving the economic health of the region is a common goal and requires policy makers to understand how changes in the region's population will affect the opportunities for economic growth.

This chapter provides detailed demographic information summarizing historic population growth, current population, regional and municipal population density, population forecasts, and current education attainment. Southwest Michigan is comprised of Berrien, Cass, and Van Buren Counties and will, from this point in this report, be known as southwest Michigan.

Population Trends and Characteristics

Population Growth

Southwest Michigan is dominated by agricultural land uses. Population centers consist of smaller cities that disperse into rolling farms, orchards, and vineyards. Berrien and Van Buren Counties both have a high number of vacation homes on the Lake Michigan shoreline and while Cass County lacks Lake Michigan access, like the other two counties, it does have inland lakes with lake homes clustered near their shores.

In 2010 the total population of southwest Michigan was 285,363. Since 1950, southwest Michigan has gained 96,077 residents, 50.8 percent of its 1950 population. This growth has not been even or constant between 1950 and 2010. Like many parts of the Midwest, most of the population growth occurred during the post WWII era now known as the "baby boom." By 2010 the population had fallen 4,465 persons or 1.5 percent since its peak in 2000. Population loss is not unknown to southwest Michigan as it has also occurred from 1980 to 1990. Since 1980, the population of southwest Michigan has not risen above 290,000 people or dropped below 280,000 people.

71.7 percent of the population of southwest Michigan now resides in a Township, 20.2 percent resides in a City, and the final 8.2 percent resides in a Village. This is the greatest percentage and number of the southwest Michigan population residing in Townships ever in the history of the CEDS process. This has occurred while the total number of persons residing in southwest Michigan has decreased, accelerating the Townships' growth of the relative share of the total southwest Michigan population.

Berrien County has 55.0 percent of the total population of southwest Michigan. This is the lowest percentage in the history of the CEDS, down 7.2 percent from 1950 when the

Table 1: Population Counts for Southwest Michigan 1950-2010

Jurisdiction	Census 1950	Census 1960	Census 1970	Census 1980	Census 1990	Census 2000	Census 2010	% Change 1950-2010	% Change 2000-2010
Berrien County - Cities	52,271	56,947	53,434	51,342	47,485	44,922	41,850	-19.9	-6.8
Berrien County - Villages	5,845	6,877	7,529	8,278	7,737	8,270	7,927	35.6	-4.1
Berrien County - Remaining Townships	59,647	88,169	102,912	111,656	106,158	109,266	107,036	79.4	-2.0
Berrien County Total	117,763	151,993	163,875	171,276	161,380	162,458	156,813	33.2	-3.5
Cass County - Cities	6,542	7,208	6,583	6,307	6,409	6,147	5,879	-10.1	-4.4
Cass County - Villages	3,517	4,359	4,781	4,649	4,514	4,478	4,532	28.9	1.2
Cass County - Remaining Townships	18,126	25,365	31,948	38,543	38,552	40,474	41,881	131.1	3.5
Cass County Total	28,185	36,932	43,312	49,499	49,475	51,099	52,292	85.5	2.3
Van Buren County - Cities	9,783	14,379	11,830	11,253	10,595	10,245	9,802	0.2	-4.3
Van Buren County - Villages	6,635	7,688	9,346	10,511	10,701	11,418	10,899	64.3	-4.5
Van Buren County - Remaining Townships	26,920	33,742	34,997	45,050	48,764	54,608	55,557	106.4	1.7
Van Buren County Total	43,338	55,809	56,173	66,814	70,060	76,271	76,258	76.0	0.0
Southwest Michigan - Cities	68,596	78,534	71,847	68,902	64,489	61,314	57,531	-16.1	-6.2
Southwest Michigan - Villages	15,997	18,924	21,656	23,438	22,952	24,166	23,358	46.0	-3.3
Southwest Michigan - Remaining Townships	104,693	147,276	169,857	195,249	193,474	204,348	204,474	95.3	0.1
Southwest Michigan Total	189,286	244,734	263,360	287,589	280,915	289,828	285,363	50.8	-1.5

percentage was the highest. Cass and Van Buren Counties have each increased 3.4 percent and 3.8 percent respectively and each has their largest relative share of population in the history of the CEDS. The growth in relative population was due to a loss in population over the last 10 years in Berrien County, with small amounts of growth in Cass and Van Buren Counties.

Population Density

Berrien County has the highest population density in southwest Michigan. Berrien County leads the region in the number of its square miles in cities and the average population density of those cities. Berrien County's villages and townships have the highest average population density. Van Buren County has the second highest population density on average of its cities, villages, and townships. Cass County has the lowest population density on average of its cities, villages, and townships.

Table 2: Population Density by County 2010

	Total Square Miles	Average Resident Per Square Mile
Berrien County	568	276.2
Cass County	523	100.1
Van Buren County	574	132.8

Table 3: Population Density by Municipal Type 2010

	Land Area (sq. mi)	Average Density of Municipal Type (Average Residents per sq. mi)
Berrien County		
City	22.758	1698.166
Village	7.808	1082.842
Township	544.989	263.993
Cass County		
City	4.464	1316.951
Village	4.919	1024.832
Township	518.100	104.956
Van Buren County		
City	7.548	1291.893
Village	13.260	772.063
Township	566.775	115.894

Population Projections

Population projections are useful to help the discussion of potentially where those persons will locate themselves and how the changes in population centers will affect the economy. The following section documents population projections up to 2035 for each municipality in Berrien, Cass, and Van Buren Counties within several categories.[1] In the next 25 years southwest Michigan is expected to gain 13,925 persons, an increase of 4.9 percent. This growth is small and does not happen evenly across southwest Michigan. Berrien County is projected to lose nearly 700 residents, while Cass will gain slightly less than 4,000 residents and Van Buren will gain the bulk of the increase at nearly 9,000 residents.

Table 4: Population Projections for Berrien, Cass, and Van Buren Counties

	2010	2015	2020	2025	2030	2035
Berrien County	156,813	159,315	156,512	156,099	156,054	156,117
Cass County	52,292	52,701	53,287	54,203	55,338	56,169
Van Buren County	76,258	79,593	81,566	83,652	85,053	85,002

Table 5: Percent of Projected Population in County by Municipal Type (%)

	2010	2015	2020	2025	2030	2035
Berrien County						
City	25.9	25.7	25.8	25.6	25.4	25.2
Village	4.9	4.8	4.8	4.8	4.8	4.8
Township	69.2	69.4	69.4	69.6	69.8	70.0
Cass County						
City	10.9	11.1	11.0	10.9	10.8	10.8
Village	8.4	8.4	8.2	8.0	7.8	7.7
Township	80.6	80.5	80.8	81.1	81.3	81.6
Van Buren County						
City	12.3	11.9	11.9	11.9	11.9	11.8
Village	13.7	13.6	13.4	13.3	13.3	13.2
Township	74.0	74.6	74.7	74.8	74.9	75.0

The story of population growth and decline continues the historic trend of populations leaving the traditional city and village centers and moving into adjacent townships. While the relative percentage of each county's population living in townships is expected to grow, the growth is modest. Consequently, the population growth migration from mileages and cities While both types of municipalities are expected to lose relative share in population their loss is also modest. Any large

[1] Population projections are from REMI.

change of population location is not expected when population growth is low. One of the positive outcomes from this is its contribution to a stable real estate market in the upcoming decade.

These trends of population migration to and from cities and townships are important to monitor and predict. Legacy costs of public infrastructure make up large percentages in any municipal budget. When population growth is slow for the region as a whole, intra-regional migration can cause population loss and growth between municipalities. For those municipalities that lose population, it can be difficult to maintain existing infrastructure. For those municipalities growing in population, new infrastructure may be built that then in the future could become costly to maintain. This problem is particularly salient in Michigan due to caps on property taxes on municipalities by the state. As larger shares of the population choose to live in townships, there is less tax revenue available to build and maintain the infrastructure needs of those populations. Additionally, adaptive reuse can be challenging because rarely does public infrastructure in residential areas have the capacity needed for industrial development. These legacy costs can syphon away much needed public funds that could support upgrades in infrastructure that support economic development goals beyond the support for residential growth.

Historic Age Distribution

Between 1980 and 2010 the median age rose in the State of Michigan, Berrien, Cass, and Van Buren Counties. In each decade Berrien, Cass, and Van Buren County saw a median age increase of over three years. Cass and Berrien both had raises that were larger than the State of Michigan in each of the decades. Van Buren experienced the smallest increase in median age in all three decades and during the 1980-1990 and 2000-2010 saw increases smaller that the State of Michigan as a whole. The differences from the overall trends of the State of Michigan are small. The differences in the trends between Berrien, Cass, and Van Buren Counties are also small, but have remained consistent since 1990. Cass County has the highest median age and experiences higher jumps in that age each decade than Berrien County, who in turn has a higher age and higher jumps than Van Buren County.

Table 6: Median Age, 1980-2010

	1980	1990	2000	2010
Berrien County	29.5	33.6	37.4	41
Cass County	30.5	34.4	38.5	42.6
Van Buren County	29.7	33.3	36.6	39.8
Southwest Michigan	29.7	33.7	37.2	*NA*
Michigan	28.8	32.6	35.5	38.9

Appendix C
2024 Calibrated Model Fire Flow Results Table

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
J-267	False	Failed	1,000.0000	189.4762	20
J-264	False	Failed	1,000.0000	213.3295	20
J-322	False	Failed	1,000.0000	216.4008	20
J-276	False	Failed	1,000.0000	230.8516	20
H-143	True	Passed	1,000.0000	1,097.4772	20
J-376	True	Passed	1,000.0000	1,099.2168	20
H-144	True	Passed	1,000.0000	1,183.2432	20
J-375	True	Passed	1,000.0000	1,184.7557	20
H-125	True	Passed	1,000.0000	1,214.3513	20
J-266	True	Passed	1,000.0000	1,214.4478	20
H-20	True	Passed	1,000.0000	1,284.5370	20
J-296	True	Passed	1,000.0000	1,287.6447	20
J-355	True	Passed	1,000.0000	1,294.0197	20
Hydrant 2 - Flow	True	Passed	1,000.0000	1,306.5099	20
J-354	True	Passed	1,000.0000	1,309.3424	20
J-347	True	Passed	1,000.0000	1,345.9562	20
H-17	True	Passed	1,000.0000	1,381.0122	20
J-299	True	Passed	1,000.0000	1,385.0670	20
H-16	True	Passed	1,000.0000	1,405.9951	20
J-298	True	Passed	1,000.0000	1,408.8191	20
H-32	True	Passed	1,000.0000	1,410.5702	20
Getman Corporation	True	Passed	1,000.0000	1,415.9010	20
J-1	True	Passed	1,000.0000	1,416.1399	20
H-33	True	Passed	1,000.0000	1,419.0062	20
J-331	True	Passed	1,000.0000	1,419.5088	20
J-382	True	Passed	1,000.0000	1,421.1556	20
J-2	True	Passed	1,000.0000	1,421.6665	20
Hydrant 3 - Test	True	Passed	1,000.0000	1,427.8944	20
J-353	True	Passed	1,000.0000	1,427.9725	20
H-43	True	Passed	1,000.0000	1,430.0217	20
H-34	True	Passed	1,000.0000	1,432.9634	20
J-3	True	Passed	1,000.0000	1,433.0396	20
J-28	True	Passed	1,000.0000	1,433.8130	20
J-379	True	Passed	1,000.0000	1,433.9563	20
Marrone Michigan Manufacturing	True	Passed	1,000.0000	1,434.8596	20
J-384	True	Passed	1,000.0000	1,434.9916	20
Green Sprout	True	Passed	1,000.0000	1,435.1893	20
Hydrant 32 - Flow	True	Passed	1,000.0000	1,442.6743	20
J-4	True	Passed	1,000.0000	1,442.7557	20
Hydrant 31 - Test	True	Passed	1,000.0000	1,453.1138	20
J-5	True	Passed	1,000.0000	1,453.1837	20
J-44	True	Passed	1,000.0000	1,462.5261	20
H-37	True	Passed	1,000.0000	1,464.4305	20
J-6	True	Passed	1,000.0000	1,464.4814	20
J-297	True	Passed	1,000.0000	1,466.0546	20
H-38	True	Passed	1,000.0000	1,474.3047	20

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
J-7	True	Passed	1,000.0000	1,474.3560	20
H-7	True	Passed	1,000.0000	1,480.8184	20
H-39	True	Passed	1,000.0000	1,480.8877	20
J-330	True	Passed	1,000.0000	1,481.8201	20
J-45	True	Passed	1,000.0000	1,483.0155	20
J-8	True	Passed	1,000.0000	1,484.5023	20
H-40	True	Passed	1,000.0000	1,495.1689	20
J-9	True	Passed	1,000.0000	1,495.2400	20
H-41	True	Passed	1,000.0000	1,497.2567	20
H-87	True	Passed	1,000.0000	1,500.6835	20
J-10	True	Passed	1,000.0000	1,504.6980	20
J-233	True	Passed	1,000.0000	1,505.0651	20
J-244	True	Passed	1,000.0000	1,506.7660	20
J-11	True	Passed	1,000.0000	1,507.3174	20
J-307	True	Passed	1,000.0000	1,507.6233	20
H-6	True	Passed	1,000.0000	1,509.9941	20
J-27	True	Passed	1,000.0000	1,511.5684	20
H-42	True	Passed	1,000.0000	1,512.1019	20
J-26	True	Passed	1,000.0000	1,512.1356	20
J-308	True	Passed	1,000.0000	1,512.6448	20
H-110	True	Passed	1,000.0000	1,516.1865	20
J-227	True	Passed	1,000.0000	1,519.0151	20
H-44	True	Passed	1,000.0000	1,525.6783	20
J-360	True	Passed	1,000.0000	1,528.4271	20
J-29	True	Passed	1,000.0000	1,530.8240	20
H-46	True	Passed	1,000.0000	1,534.6127	20
J-337	True	Passed	1,000.0000	1,540.1207	20
J-30	True	Passed	1,000.0000	1,540.7605	20
J-12	True	Passed	1,000.0000	1,541.6744	20
J-352	True	Passed	1,000.0000	1,542.5952	20
H-3	True	Passed	1,000.0000	1,542.5956	20
J-309	True	Passed	1,000.0000	1,550.4707	20
J-310	True	Passed	1,000.0000	1,556.0291	20
J-13	True	Passed	1,000.0000	1,564.3844	20
H-4	True	Passed	1,000.0000	1,566.0140	20
J-193	True	Passed	1,000.0000	1,567.6019	20
J-311	True	Passed	1,000.0000	1,572.5402	20
H-81	True	Passed	1,000.0000	1,583.8988	20
J-31	True	Passed	1,000.0000	1,589.8660	20
J-270	True	Passed	1,000.0000	1,590.9460	20
J-271	True	Passed	1,000.0000	1,591.3517	20
J-192	True	Passed	1,000.0000	1,591.6063	20
H-128	True	Passed	1,000.0000	1,594.2319	20
H-47	True	Passed	1,000.0000	1,595.1241	20
J-272	True	Passed	1,000.0000	1,596.3306	20
J-14	True	Passed	1,000.0000	1,604.8923	20
J-245	True	Passed	1,000.0000	1,616.9067	20

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
H-127	True	Passed	1,000.0000	1,618.1389	20
J-273	True	Passed	1,000.0000	1,621.4690	20
J-36	True	Passed	1,000.0000	1,623.9429	20
H-45	True	Passed	1,000.0000	1,625.4824	20
J-38	True	Passed	1,000.0000	1,633.6033	20
H-129	True	Passed	1,000.0000	1,633.9087	20
J-35	True	Passed	1,000.0000	1,633.9868	20
J-269	True	Passed	1,000.0000	1,637.8877	20
H-54	True	Passed	1,000.0000	1,643.6403	20
J-249	True	Passed	1,000.0000	1,648.3944	20
J-329	True	Passed	1,000.0000	1,649.1530	20
H-50	True	Passed	1,000.0000	1,650.2284	20
J-34	True	Passed	1,000.0000	1,653.6371	20
H-18	True	Passed	1,000.0000	1,656.0619	20
H-48	True	Passed	1,000.0000	1,656.4130	20
H-8	True	Passed	1,000.0000	1,658.0587	20
J-300	True	Passed	1,000.0000	1,659.0997	20
H-86	True	Passed	1,000.0000	1,661.2921	20
J-326	True	Passed	1,000.0000	1,662.3099	20
Hydrant 60 - Flow	True	Passed	1,000.0000	1,662.6007	20
H-118	True	Passed	1,000.0000	1,662.8070	20
J-306	True	Passed	1,000.0000	1,663.2887	20
J-246	True	Passed	1,000.0000	1,664.7556	20
J-15	True	Passed	1,000.0000	1,665.4244	20
H-10	True	Passed	1,000.0000	1,666.1511	20
J-305	True	Passed	1,000.0000	1,666.2090	20
J-367	True	Passed	1,000.0000	1,666.2351	20
J-325	True	Passed	1,000.0000	1,669.5787	20
J-327	True	Passed	1,000.0000	1,670.2637	20
H-132	True	Passed	1,000.0000	1,677.0015	20
J-238	True	Passed	1,000.0000	1,677.6534	20
H-53	True	Passed	1,000.0000	1,678.4301	20
H-120	True	Passed	1,000.0000	1,681.0916	20
J-328	True	Passed	1,000.0000	1,682.7760	20
J-39	True	Passed	1,000.0000	1,686.3110	20
J-229	True	Passed	1,000.0000	1,688.7743	20
J-188	True	Passed	1,000.0000	1,692.2485	20
H-134	True	Passed	1,000.0000	1,697.4733	20
H-19	True	Passed	1,000.0000	1,700.9258	20
J-324	True	Passed	1,000.0000	1,704.3235	20
J-77	True	Passed	1,000.0000	1,704.4686	20
J-359	True	Passed	1,000.0000	1,706.3662	20
H-49	True	Passed	1,000.0000	1,706.5406	20
Hydrant 59 - Test	True	Passed	1,000.0000	1,708.6653	20
J-361	True	Passed	1,000.0000	1,709.1989	20
J-40	True	Passed	1,000.0000	1,709.3394	20
J-33	True	Passed	1,000.0000	1,711.8342	20

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
J-304	True	Passed	1,000.0000	1,712.4998	20
J-16	True	Passed	1,000.0000	1,714.3892	20
J-41	True	Passed	1,000.0000	1,714.7327	20
J-374	True	Passed	1,000.0000	1,715.5186	20
J-76	True	Passed	1,000.0000	1,718.3372	20
J-250	True	Passed	1,000.0000	1,721.7648	20
J-323	True	Passed	1,000.0000	1,724.7496	20
H-9	True	Passed	1,000.0000	1,724.7775	20
H-52	True	Passed	1,000.0000	1,726.2965	20
H-51	True	Passed	1,000.0000	1,729.0734	20
J-17	True	Passed	1,000.0000	1,729.5254	20
J-78	True	Passed	1,000.0000	1,730.4447	20
J-25	True	Passed	1,000.0000	1,731.6171	20
J-21	True	Passed	1,000.0000	1,732.3060	20
J-19	True	Passed	1,000.0000	1,733.5410	20
J-20	True	Passed	1,000.0000	1,734.0369	20
H-130	True	Passed	1,000.0000	1,735.2513	20
J-42	True	Passed	1,000.0000	1,735.7690	20
J-22	True	Passed	1,000.0000	1,735.8008	20
H-60	True	Passed	1,000.0000	1,736.4230	20
J-220	True	Passed	1,000.0000	1,736.4406	20
J-23	True	Passed	1,000.0000	1,736.5470	20
J-268	True	Passed	1,000.0000	1,739.4636	20
J-75	True	Passed	1,000.0000	1,741.6302	20
J-258	True	Passed	1,000.0000	1,743.1409	20
J-251	True	Passed	1,000.0000	1,743.4802	20
H-111	True	Passed	1,000.0000	1,745.6105	20
H-133	True	Passed	1,000.0000	1,750.9053	20
J-219	True	Passed	1,000.0000	1,751.3473	20
J-79	True	Passed	1,000.0000	1,755.9917	20
J-218	True	Passed	1,000.0000	1,758.6934	20
J-257	True	Passed	1,000.0000	1,759.8663	20
J-221	True	Passed	1,000.0000	1,761.5222	20
J-32	True	Passed	1,000.0000	1,768.0928	20
J-228	True	Passed	1,000.0000	1,769.3196	20
H-5	True	Passed	1,000.0000	1,769.3229	20
H-131	True	Passed	1,000.0000	1,770.8104	20
J-256	True	Passed	1,000.0000	1,772.7466	20
J-312	True	Passed	1,000.0000	1,773.4711	20
J-255	True	Passed	1,000.0000	1,777.1720	20
J-320	True	Passed	1,000.0000	1,778.5310	20
J-321	True	Passed	1,000.0000	1,779.6979	20
H-100	True	Passed	1,000.0000	1,783.8241	20
J-366	True	Passed	1,000.0000	1,786.4244	20
J-134	True	Passed	1,000.0000	1,789.5199	20
Hydrant 123 - Test	True	Passed	1,000.0000	1,790.4396	20
J-74	True	Passed	1,000.0000	1,794.5571	20

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
H-12	True	Passed	1,000.0000	1,794.9578	20
J-362	True	Passed	1,000.0000	1,796.1304	20
J-73	True	Passed	1,000.0000	1,796.3204	20
J-363	True	Passed	1,000.0000	1,797.3933	20
J-313	True	Passed	1,000.0000	1,803.7518	20
J-314	True	Passed	1,000.0000	1,807.3268	20
J-346	True	Passed	1,000.0000	1,811.9327	20
H-140	True	Passed	1,000.0000	1,816.6013	20
J-317	True	Passed	1,000.0000	1,818.1973	20
Hydrant 84 - Test	True	Passed	1,000.0000	1,819.9636	20
J-318	True	Passed	1,000.0000	1,820.4363	20
Hydrant 124 - Flow	True	Passed	1,000.0000	1,821.9895	20
J-319	True	Passed	1,000.0000	1,823.5835	20
J-53	True	Passed	1,000.0000	1,824.6897	20
J-290	True	Passed	1,000.0000	1,824.8811	20
J-133	True	Passed	1,000.0000	1,825.8262	20
H-137	True	Passed	1,000.0000	1,826.1416	20
H-63	True	Passed	1,000.0000	1,828.3497	20
J-72	True	Passed	1,000.0000	1,828.5242	20
J-348	True	Passed	1,000.0000	1,829.2357	20
J-217	True	Passed	1,000.0000	1,831.0811	20
J-52	True	Passed	1,000.0000	1,831.1501	20
J-71	True	Passed	1,000.0000	1,831.1578	20
Hydrant 18 - Flow	True	Passed	1,000.0000	1,831.4027	20
J-54	True	Passed	1,000.0000	1,832.3521	20
Hydrant 8 - Flow	True	Passed	1,000.0000	1,836.2869	20
H-99	True	Passed	1,000.0000	1,836.3148	20
J-148	True	Passed	1,000.0000	1,836.4392	20
J-147	True	Passed	1,000.0000	1,837.2401	20
J-143	True	Passed	1,000.0000	1,841.5569	20
J-291	True	Passed	1,000.0000	1,843.3154	20
Hydrant 40 - Flow	True	Passed	1,000.0000	1,843.3899	20
H-15	True	Passed	1,000.0000	1,843.7516	20
J-247	True	Passed	1,000.0000	1,846.2520	20
J-315	True	Passed	1,000.0000	1,847.6652	20
J-368	True	Passed	1,000.0000	1,847.9274	20
J-248	True	Passed	1,000.0000	1,850.8889	20
H-11	True	Passed	1,000.0000	1,850.9309	20
H-84	True	Passed	1,000.0000	1,850.9795	20
J-364	True	Passed	1,000.0000	1,851.0696	20
J-316	True	Passed	1,000.0000	1,851.0948	20
H-85	True	Passed	1,000.0000	1,851.8115	20
J-365	True	Passed	1,000.0000	1,852.8738	20
J-303	True	Passed	1,000.0000	1,856.0601	20
J-243	True	Passed	1,000.0000	1,860.2697	20
J-294	True	Passed	1,000.0000	1,860.8153	20
J-47	True	Passed	1,000.0000	1,861.3781	20

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
J-295	True	Passed	1,000.0000	1,863.8412	20
H-88	True	Passed	1,000.0000	1,867.3916	20
H-80	True	Passed	1,000.0000	1,868.3810	20
H-141	True	Passed	1,000.0000	1,868.5597	20
J-357	True	Passed	1,000.0000	1,871.7400	20
J-358	True	Passed	1,000.0000	1,871.9667	20
J-70	True	Passed	1,000.0000	1,872.0204	20
J-356	True	Passed	1,000.0000	1,872.3474	20
J-301	True	Passed	1,000.0000	1,872.5961	20
J-222	True	Passed	1,000.0000	1,873.0151	20
H-65	True	Passed	1,000.0000	1,873.7186	20
J-351	True	Passed	1,000.0000	1,875.2981	20
J-49	True	Passed	1,000.0000	1,875.6501	20
J-223	True	Passed	1,000.0000	1,875.7925	20
H-126	True	Passed	1,000.0000	1,877.9908	20
J-46	True	Passed	1,000.0000	1,878.1852	20
J-132	True	Passed	1,000.0000	1,878.7363	20
J-242	True	Passed	1,000.0000	1,878.7830	20
H-55	True	Passed	1,000.0000	1,882.5736	20
J-274	True	Passed	1,000.0000	1,883.9092	20
H-78	True	Passed	1,000.0000	1,884.3926	20
J-149	True	Passed	1,000.0000	1,888.3639	20
J-120	True	Passed	1,000.0000	1,891.2290	20
J-82	True	Passed	1,000.0000	1,891.4940	20
J-150	True	Passed	1,000.0000	1,891.6919	20
J-275	True	Passed	1,000.0000	1,893.3389	20
H-69	True	Passed	1,000.0000	1,893.7570	20
J-282	True	Passed	1,000.0000	1,894.3595	20
H-71	True	Passed	1,000.0000	1,894.6505	20
J-265	True	Passed	1,000.0000	1,895.1584	20
H-23	True	Passed	1,000.0000	1,895.3668	20
H-123	True	Passed	1,000.0000	1,897.8810	20
J-89	True	Passed	1,000.0000	1,898.0267	20
J-90	True	Passed	1,000.0000	1,898.0669	20
J-91	True	Passed	1,000.0000	1,898.2533	20
J-92	True	Passed	1,000.0000	1,898.6118	20
J-283	True	Passed	1,000.0000	1,899.2004	20
Hydrant 85 - Test	True	Passed	1,000.0000	1,899.7261	20
J-61	True	Passed	1,000.0000	1,900.0787	20
Hydrant 17 - Test	True	Passed	1,000.0000	1,900.6401	20
H-74	True	Passed	1,000.0000	1,901.1997	20
J-349	True	Passed	1,000.0000	1,901.4850	20
H-121	True	Passed	1,000.0000	1,901.6204	20
H-61	True	Passed	1,000.0000	1,902.0131	20
H-21	True	Passed	1,000.0000	1,902.7223	20
J-263	True	Passed	1,000.0000	1,902.7484	20
H-122	True	Passed	1,000.0000	1,902.8101	20

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
J-163	True	Passed	1,000.0000	1,904.9385	20
J-64	True	Passed	1,000.0000	1,905.4973	20
J-50	True	Passed	1,000.0000	1,906.5286	20
J-146	True	Passed	1,000.0000	1,906.5385	20
J-350	True	Passed	1,000.0000	1,907.2068	20
J-166	True	Passed	1,000.0000	1,907.5153	20
H-24	True	Passed	1,000.0000	1,907.6591	20
J-281	True	Passed	1,000.0000	1,907.7869	20
J-162	True	Passed	1,000.0000	1,908.1324	20
J-287	True	Passed	1,000.0000	1,908.4890	20
H-66	True	Passed	1,000.0000	1,908.5361	20
J-302	True	Passed	1,000.0000	1,909.0303	20
J-159	True	Passed	1,000.0000	1,909.0333	20
J-62	True	Passed	1,000.0000	1,909.0647	20
J-160	True	Passed	1,000.0000	1,909.2521	20
J-284	True	Passed	1,000.0000	1,909.4479	20
J-63	True	Passed	1,000.0000	1,909.6289	20
J-285	True	Passed	1,000.0000	1,909.8898	20
J-286	True	Passed	1,000.0000	1,911.3214	20
H-22	True	Passed	1,000.0000	1,911.4999	20
J-117	True	Passed	1,000.0000	1,912.7751	20
H-116	True	Passed	1,000.0000	1,913.0836	20
J-51	True	Passed	1,000.0000	1,914.0917	20
H-79	True	Passed	1,000.0000	1,914.8336	20
J-118	True	Passed	1,000.0000	1,915.1802	20
J-280	True	Passed	1,000.0000	1,915.3956	20
J-293	True	Passed	1,000.0000	1,915.8462	20
J-83	True	Passed	1,000.0000	1,915.8639	20
J-224	True	Passed	1,000.0000	1,915.9766	20
J-151	True	Passed	1,000.0000	1,918.8014	20
H-77	True	Passed	1,000.0000	1,918.8960	20
J-48	True	Passed	1,000.0000	1,919.1018	20
H-102	True	Passed	1,000.0000	1,919.4083	20
J-119	True	Passed	1,000.0000	1,919.7263	20
J-135	True	Passed	1,000.0000	1,919.9513	20
H-98	True	Passed	1,000.0000	1,920.7690	20
J-369	True	Passed	1,000.0000	1,921.9343	20
J-80	True	Passed	1,000.0000	1,922.2139	20
J-98	True	Passed	1,000.0000	1,923.2466	20
J-161	True	Passed	1,000.0000	1,924.8551	20
J-69	True	Passed	1,000.0000	1,925.1494	20
H-101	True	Passed	1,000.0000	1,926.0953	20
J-97	True	Passed	1,000.0000	1,927.2148	20
J-84	True	Passed	1,000.0000	1,927.4922	20
J-128	True	Passed	1,000.0000	1,927.9399	20
J-68	True	Passed	1,000.0000	1,928.2416	20
J-81	True	Passed	1,000.0000	1,929.0560	20

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
H-73	True	Passed	1,000.0000	1,929.3682	20
J-125	True	Passed	1,000.0000	1,930.2235	20
H-62	True	Passed	1,000.0000	1,930.8571	20
J-288	True	Passed	1,000.0000	1,931.1421	20
J-115	True	Passed	1,000.0000	1,931.2145	20
H-64	True	Passed	1,000.0000	1,932.4534	20
H-83	True	Passed	1,000.0000	1,932.6937	20
J-144	True	Passed	1,000.0000	1,933.0519	20
J-145	True	Passed	1,000.0000	1,934.8763	20
J-137	True	Passed	1,000.0000	1,935.8929	20
J-138	True	Passed	1,000.0000	1,936.0597	20
J-58	True	Passed	1,000.0000	1,936.1975	20
J-56	True	Passed	1,000.0000	1,937.0891	20
J-152	True	Passed	1,000.0000	1,937.5105	20
J-136	True	Passed	1,000.0000	1,938.2047	20
J-122	True	Passed	1,000.0000	1,938.3717	20
H-104	True	Passed	1,000.0000	1,938.9783	20
J-86	True	Passed	1,000.0000	1,939.0110	20
J-241	True	Passed	1,000.0000	1,939.0298	20
J-116	True	Passed	1,000.0000	1,939.2897	20
J-59	True	Passed	1,000.0000	1,940.1322	20
J-55	True	Passed	1,000.0000	1,941.3905	20
H-72	True	Passed	1,000.0000	1,941.6218	20
J-124	True	Passed	1,000.0000	1,941.7145	20
H-91	True	Passed	1,000.0000	1,942.1862	20
J-100	True	Passed	1,000.0000	1,942.6367	20
J-121	True	Passed	1,000.0000	1,942.8704	20
J-87	True	Passed	1,000.0000	1,943.1251	20
H-96	True	Passed	1,000.0000	1,944.0359	20
J-292	True	Passed	1,000.0000	1,948.6138	20
J-252	True	Passed	1,000.0000	1,949.7212	20
J-66	True	Passed	1,000.0000	1,949.8156	20
J-254	True	Passed	1,000.0000	1,950.3750	20
J-57	True	Passed	1,000.0000	1,951.6548	20
J-126	True	Passed	1,000.0000	1,952.5815	20
J-142	True	Passed	1,000.0000	1,952.7043	20
J-253	True	Passed	1,000.0000	1,952.7281	20
J-370	True	Passed	1,000.0000	1,952.8484	20
H-70	True	Passed	1,000.0000	1,953.1050	20
H-67	True	Passed	1,000.0000	1,953.3231	20
J-110	True	Passed	1,000.0000	1,954.5511	20
J-67	True	Passed	1,000.0000	1,954.7714	20
J-60	True	Passed	1,000.0000	1,955.7424	20
H-68	True	Passed	1,000.0000	1,955.8639	20
J-334	True	Passed	1,000.0000	1,956.5890	20
J-289	True	Passed	1,000.0000	1,957.2140	20
H-95	True	Passed	1,000.0000	1,957.6488	20

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
J-225	True	Passed	1,000.0000	1,958.1309	20
J-139	True	Passed	1,000.0000	1,958.4039	20
J-154	True	Passed	1,000.0000	1,958.7000	20
J-140	True	Passed	1,000.0000	1,958.9668	20
J-237	True	Passed	1,000.0000	1,959.4053	20
J-85	True	Passed	1,000.0000	1,959.4868	20
J-127	True	Passed	1,000.0000	1,960.3264	20
J-111	True	Passed	1,000.0000	1,960.4951	20
J-109	True	Passed	1,000.0000	1,960.8525	20
J-389	True	Passed	1,000.0000	1,961.0043	20
J-141	True	Passed	1,000.0000	1,961.2592	20
J-93	True	Passed	1,000.0000	1,961.8229	20
J-114	True	Passed	1,000.0000	1,962.5613	20
J-113	True	Passed	1,000.0000	1,962.9005	20
J-153	True	Passed	1,000.0000	1,964.1653	20
J-131	True	Passed	1,000.0000	1,964.3541	20
J-112	True	Passed	1,000.0000	1,964.4366	20
H-105	True	Passed	1,000.0000	1,965.7617	20
J-129	True	Passed	1,000.0000	1,966.8116	20
J-130	True	Passed	1,000.0000	1,967.2239	20
J-158	True	Passed	1,000.0000	1,969.8768	20
J-339	True	Passed	1,000.0000	1,970.6531	20
H-92	True	Passed	1,000.0000	1,970.9946	20
J-171	True	Passed	1,000.0000	1,974.3021	20
J-103	True	Passed	1,000.0000	1,974.4879	20
J-332	True	Passed	1,000.0000	1,974.9227	20
J-344	True	Passed	1,000.0000	1,974.9818	20
Freestone Pickle	True	Passed	1,000.0000	1,975.0902	20
H-106	True	Passed	1,000.0000	1,975.6898	20
J-88	True	Passed	1,000.0000	1,976.1217	20
H-117	True	Passed	1,000.0000	1,976.2064	20
J-157	True	Passed	1,000.0000	1,976.2249	20
J-279	True	Passed	1,000.0000	1,976.3351	20
J-156	True	Passed	1,000.0000	1,976.5962	20
J-165	True	Passed	1,000.0000	1,976.8823	20
J-239	True	Passed	1,000.0000	1,977.2065	20
J-164	True	Passed	1,000.0000	1,977.3121	20
J-155	True	Passed	1,000.0000	1,977.4065	20
J-94	True	Passed	1,000.0000	1,977.5360	20
J-278	True	Passed	1,000.0000	1,977.6753	20
J-95	True	Passed	1,000.0000	1,977.6929	20
J-277	True	Passed	1,000.0000	1,977.9128	20
Hydrant 63 - Flow	True	Passed	1,000.0000	1,977.9612	20
J-345	True	Passed	1,000.0000	1,978.0952	20
J-240	True	Passed	1,000.0000	1,978.2930	20
H-107	True	Passed	1,000.0000	1,978.9186	20
J-230	True	Passed	1,000.0000	1,979.0540	20

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
J-371	True	Passed	1,000.0000	1,979.0852	20
J-236	True	Passed	1,000.0000	1,979.2107	20
J-235	True	Passed	1,000.0000	1,979.3224	20
H-89	True	Passed	1,000.0000	1,979.4131	20
J-96	True	Passed	1,000.0000	1,979.4938	20
H-97	True	Passed	1,000.0000	1,979.5599	20
H-119	True	Passed	1,000.0000	1,979.6602	20
J-99	True	Passed	1,000.0000	1,979.6940	20
H-90	True	Passed	1,000.0000	1,979.7168	20
J-234	True	Passed	1,000.0000	1,979.8099	20
J-108	True	Passed	1,000.0000	1,980.0452	20
H-114	True	Passed	1,000.0000	1,980.1512	20
J-333	True	Passed	1,000.0000	1,980.4064	20
J-232	True	Passed	1,000.0000	1,980.5314	20
J-231	True	Passed	1,000.0000	1,980.9093	20
J-179	True	Passed	1,000.0000	1,981.7451	20
J-107	True	Passed	1,000.0000	1,982.4867	20
Hydrant 103 - Test	True	Passed	1,000.0000	1,982.9803	20
J-106	True	Passed	1,000.0000	1,983.1124	20
H-75	True	Passed	1,000.0000	1,983.2010	20
J-185	True	Passed	1,000.0000	1,984.9496	20
J-101	True	Passed	1,000.0000	1,985.0596	20
H-94	True	Passed	1,000.0000	1,987.1382	20
J-335	True	Passed	1,000.0000	1,987.1859	20
J-186	True	Passed	1,000.0000	1,987.1973	20
J-172	True	Passed	1,000.0000	1,987.2659	20
Hydrant 104 - Flow	True	Passed	1,000.0000	1,987.5471	20
J-105	True	Passed	1,000.0000	1,987.7817	20
J-187	True	Passed	1,000.0000	1,987.8367	20
J-104	True	Passed	1,000.0000	1,988.1014	20
J-226	True	Passed	1,000.0000	1,988.1293	20
J-183	True	Passed	1,000.0000	1,988.8717	20
J-182	True	Passed	1,000.0000	1,989.2888	20
J-195	True	Passed	1,000.0000	1,991.8784	20
J-175	True	Passed	1,000.0000	1,992.5685	20
J-184	True	Passed	1,000.0000	1,993.6399	20
H-76	True	Passed	1,000.0000	1,993.8357	20
J-168	True	Passed	1,000.0000	1,996.9384	20
J-102	True	Passed	1,000.0000	1,997.2947	20
J-176	True	Passed	1,000.0000	1,997.4911	20
H-82	True	Passed	1,000.0000	1,999.2692	20
J-178	True	Passed	1,000.0000	1,999.5234	20
J-170	True	Passed	1,000.0000	1,999.5970	20
H-93	True	Passed	1,000.0000	1,999.6039	20
J-169	True	Passed	1,000.0000	1,999.6420	20
J-167	True	Passed	1,000.0000	1,999.6720	20
J-336	True	Passed	1,000.0000	1,999.8623	20

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
J-177	True	Passed	1,000.0000	2,001.2617	20
J-173	True	Passed	1,000.0000	2,002.3490	20
H-28	True	Passed	1,000.0000	2,002.3940	20
H-112	True	Passed	1,000.0000	2,003.6163	20
J-174	True	Passed	1,000.0000	2,004.0414	20
J-260	True	Passed	1,000.0000	2,004.4087	20
J-189	True	Passed	1,000.0000	2,004.7474	20
J-190	True	Passed	1,000.0000	2,007.5060	20
H-27	True	Passed	1,000.0000	2,007.9149	20
J-200	True	Passed	1,000.0000	2,008.6747	20
J-180	True	Passed	1,000.0000	2,009.7444	20
J-181	True	Passed	1,000.0000	2,010.3561	20
J-216	True	Passed	1,000.0000	2,013.7821	20
Hydrant 72 - Flow	True	Passed	1,000.0000	2,015.2290	20
J-202	True	Passed	1,000.0000	2,017.3057	20
J-199	True	Passed	1,000.0000	2,020.2600	20
J-198	True	Passed	1,000.0000	2,023.6909	20
J-191	True	Passed	1,000.0000	2,026.2194	20
Hydrant 73 - Test	True	Passed	1,000.0000	2,042.1118	20
J-194	True	Passed	1,000.0000	2,042.6591	20
J-261	True	Passed	1,000.0000	2,051.5063	20
H-139	True	Passed	1,000.0000	2,051.5276	20
H-138	True	Passed	1,000.0000	2,051.5286	20
H-31	True	Passed	1,000.0000	2,051.5605	20
Hydrant 65 - Test	True	Passed	1,000.0000	2,051.5623	20
J-213	True	Passed	1,000.0000	2,051.6455	20
J-214	True	Passed	1,000.0000	2,051.6555	20
J-262	True	Passed	1,000.0000	2,051.6589	20
J-215	True	Passed	1,000.0000	2,051.6594	20
J-340	True	Passed	1,000.0000	2,051.6631	20
J-341	True	Passed	1,000.0000	2,051.6675	20
J-338	True	Passed	1,000.0000	2,051.6775	20
J-201	True	Passed	1,000.0000	2,051.6804	20
J-342	True	Passed	1,000.0000	2,051.6917	20
J-196	True	Passed	1,000.0000	2,051.6934	20
J-259	True	Passed	1,000.0000	2,051.6936	20
J-197	True	Passed	1,000.0000	2,051.6941	20
J-203	True	Passed	1,000.0000	2,088.4814	20
H-25	True	Passed	1,000.0000	2,134.7354	20
J-386	True	Passed	1,000.0000	2,145.1704	20
J-209	True	Passed	1,000.0000	2,146.2776	20
J-208	True	Passed	1,000.0000	2,147.5120	20
J-377	True	Passed	1,000.0000	2,158.0000	20
J-210	True	Passed	1,000.0000	2,163.3965	20
J-211	True	Passed	1,000.0000	2,163.6533	20
H-26	True	Passed	1,000.0000	2,167.0779	20
J-207	True	Passed	1,000.0000	2,168.1458	20

Fire Flow Node FlexTable: Fire Flow Results Table

Label	Satisfies Fire Flow Constraints?	Fire Flow Status	Fire Flow (Needed) (gpm)	Fire Flow (Available) (gpm)	Pressure (Residual Lower Limit) (psi)
J-204	True	Passed	1,000.0000	2,176.7717	20
J-205	True	Passed	1,000.0000	2,180.8237	20
J-212	True	Passed	1,000.0000	2,189.8484	20
J-206	True	Passed	1,000.0000	2,213.4958	20

Appendix D
5- & 20-Year Capital Improvement Plan Cost Estimates

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Engineer's Preliminary Opinion of Costs

Project:	Bangor Water Reliability Study	**Project No.:**	23-1791
Client:	City of Bangor	**Client Project No.:**	N/A
Description:	Scope 1: Washington St WM Loop **(1,400')**	**Project Stage:**	5-Year CIP Planning
Prepared By:	Madelyn Landry, EIT	**Date Prepared:**	8/13/2024
Reviewed By:	Leah Bectel, PE	**Date Reviewed:**	8/13/2024

Item #	Item Description	Quantity	Unit	Unit Price	Total
1	Mobilization Max, 10%	1.00	LSUM	$ 52,900.00	$ 52,900.00
2	Exploratory Investigation, Vertical	50.00	Ft	$ 40.00	$ 2,000.00
3	Subgrade Undercutting, Type II	100.00	Cyd	$ 22.50	$ 2,250.00
4	Masonry and Conc Structure, Rem	10.00	Cyd	$ 150.00	$ 1,500.00
5	Dr Structure, Temp Lowering	3.00	Ea	$ 500.00	$ 1,500.00
6	Dr Structure Cover, Type Q	1.00	Ea	$ 825.00	$ 825.00
7	Dr Structure Cover, Type K	2.00	Ea	$ 825.00	$ 1,650.00
8	Dr Structure, Reconstruct	3.00	Ea	$ 750.00	$ 2,250.00
9	Sewer, CI IV, 12 inch, Tr Det B	315.00	Ft	$ 80.00	$ 25,200.00
10	Dr Structure, 48 inch dia	1.00	Ea	$ 3,000.00	$ 3,000.00
11	Sewer, Rem, Less than 24 inch	315.00	Ft	$ 16.00	$ 5,040.00
12	Cement	5.00	Ton	$ 175.00	$ 875.00
13	Machine Grading Modified	14.00	Sta	$ 3,500.00	$ 49,000.00
14	Maintenance Gravel, LM	250.00	Cyd	$ 25.00	$ 6,250.00
15	Tree, Rem, 19 inch to 36 inch	3.00	Ea	$ 1,000.00	$ 3,000.00
16	Tree, Rem, 6 inch to 18 inch	8.00	Ea	$ 650.00	$ 5,200.00
17	HMA Surface, Rem	1,540.00	Syd	$ 5.50	$ 8,470.00
18	Hydrant, Rem, Modified	1.00	Ea	$ 650.00	$ 650.00
19	Water Main, Rem	150.00	Ft	$ 20.00	$ 3,000.00
20	Flowable Fill, Non-Structural	8.00	Cyd	$ 200.00	$ 1,600.00
21	Post, Mailbox	14.00	Ea	$ 150.00	$ 2,100.00
22	Water Main, Cut and Plug, 2 inch	3.00	Ea	$ 500.00	$ 1,500.00
23	Water Main, Cut and Plug, 4 inch	1.00	Ea	$ 1,000.00	$ 1,000.00
24	Subbase, CIP	1,000.00	Cyd	$ 22.50	$ 22,500.00
25	Aggregate Base, 8 inch	3,000.00	Syd	$ 13.50	$ 40,500.00
26	HMA, 13A (2")	160.00	Ton	$ 93.50	$ 14,960.00
27	HMA, 36A (1.5")	120.00	Ton	$ 95.00	$ 11,400.00
28	HMA Approach (3.5")	30.00	Ton	$ 125.00	$ 3,750.00
29	Hand Patching	20.00	Ton	$ 200.00	$ 4,000.00
30	Driveway, Nonreinf Conc, 6 inch	110.00	Syd	$ 42.50	$ 4,675.00

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31	Fire Hydrant, Modified	1.00	Ea	$ 6,000.00	$ 6,000.00
32	Gate Valve and Box, 6 inch, Modified	1.00	Ea	$ 1,750.00	$ 1,750.00
33	Gate Valve and Box, 8 inch, Modified	2.00	Ea	$ 2,500.00	$ 5,000.00
34	Water Main, DI, 6 inch, Tr Det G, Modified	15.00	Ft	$ 250.00	$ 3,750.00
35	Water Main, DI, 8 inch, Tr Det G, Modified	1,400.00	Ft	$ 145.00	$ 203,000.00
36	Water Serv, Modified	7.00	Ea	$ 1,750.00	$ 12,250.00
37	Water Serv, Long, Modified	7.00	Ea	$ 2,500.00	$ 17,500.00
38	Curb Stop and Box	14.00	Ea	$ 750.00	$ 10,500.00
39	Sign, Type III, Rem	3.00	Ea	$ 15.00	$ 45.00
40	Post, Steel, 3 pound	45.00	Ft	$ 7.50	$ 337.50
41	Sign, Type III A/B	18.50	Sft	$ 20.00	$ 370.00
42	Pavt Mrkg, Ovly Cold Plastic, 24 inch, Stop Bar	18.00	Ft	$ 10.00	$ 180.00
43	Barricade, Type III, High Intensity, Double Sided, Lighted, Furn	10.00	Ea	$ 135.00	$ 1,350.00
44	Barricade, Type III, High Intensity, Double Sided, Lighted, Oper	10.00	Ea	$ 15.00	$ 150.00
45	Minor Traf Devices	1.00	LSUM	$ 25,200.00	$ 25,200.00
46	Plastic Drum, Fluorescent, Furn	50.00	Ea	$ 27.50	$ 1,375.00
47	Plastic Drum, Fluorescent, Oper	50.00	Ea	$ 2.50	$ 125.00
48	Sign, Type B, Temp, Prismatic, Furn	200.00	Sft	$ 7.50	$ 1,500.00
49	Sign, Type B, Temp, Prismatic, Oper	200.00	Sft	$ 1.00	$ 200.00
50	Sign, Type B, Temp, Prismatic, Spec, Furn	75.00	Sft	$ 10.00	$ 750.00
51	Sign, Type B, Temp, Prismatic, Spec, Oper	75.00	Sft	$ 1.00	$ 75.00
52	Erosion Control, Silt Fence	300.00	Ft	$ 2.50	$ 750.00
53	Erosion Control, Inlet Protection, Fabric Drop	5.00	Ea	$ 100.00	$ 500.00
54	Slope Restoration, Non-Freeway, Type B	1,210.00	Syd	$ 5.50	$ 6,655.00
	Construction Subtotal			$	581,857.50
	Construction Contingency, Engineering, Construction Administration			$	174,557.25
	Total			$	756,000.00

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Engineer's Preliminary Opinion of Costs

Project:	Bangor Water Reliability Study	**Project No.:**	23-1791
Client:	City of Bangor	**Client Project No.:**	N/A
Description:	Scope 2: Charles St WM Replacement & Loop **(330')**	**Project Stage:**	5-Year CIP Planning
Prepared By:	Madelyn Landry, EIT	**Date Prepared:**	8/13/2024
Reviewed By:	Leah Bectel, PE	**Date Reviewed:**	8/13/2024

Item #	Item Description	Quantity	Unit	Unit Price	Total
1	Mobilization Max, 10%	1.00	LSUM	$ 20,300.00	$ 20,300.00
2	Exploratory Investigation, Vertical	50.00	Ft	$ 40.00	$ 2,000.00
3	Subgrade Undercutting, Type II	100.00	Cyd	$ 22.50	$ 2,250.00
4	Masonry and Conc Structure, Rem	10.00	Cyd	$ 150.00	$ 1,500.00
5	Dr Structure, Temp Lowering	1.00	Ea	$ 500.00	$ 500.00
6	Dr Structure Cover, Adj, Case 1	1.00	Ea	$ 650.00	$ 650.00
7	Dr Structure Cover, Type Q	1.00	Ea	$ 825.00	$ 825.00
8	Dr Structure, Reconstruct	1.00	Ea	$ 750.00	$ 750.00
9	Cement	5.00	Ton	$ 175.00	$ 875.00
10	Machine Grading Modified	3.50	Sta	$ 3,500.00	$ 12,250.00
11	Maintenance Gravel, LM	200.00	Cyd	$ 25.00	$ 5,000.00
12	Tree, Rem, 19 inch to 36 inch	1.00	Ea	$ 1,000.00	$ 1,000.00
13	Tree, Rem, 6 inch to 18 inch	3.00	Ea	$ 650.00	$ 1,950.00
14	HMA Surface, Rem	1,100.00	Syd	$ 5.50	$ 6,050.00
15	Sidewalk, Rem	155.00	Syd	$ 9.00	$ 1,395.00
16	Water Main, Rem	330.00	Ft	$ 20.00	$ 6,600.00
17	Flowable Fill, Non-Structural	25.00	Cyd	$ 200.00	$ 5,000.00
18	Water Main, Cut and Plug, 2 inch	1.00	Ea	$ 1,000.00	$ 1,000.00
19	Subbase, CIP	400.00	Cyd	$ 22.50	$ 9,000.00
20	Aggregate Base, 8 inch	1,180.00	Syd	$ 13.50	$ 15,930.00
21	HMA, 13A (2")	125.00	Ton	$ 93.50	$ 11,687.50
22	HMA, 36A (1.5")	95.00	Ton	$ 95.00	$ 9,025.00
23	Hand Patching	5.00	Ton	$ 200.00	$ 1,000.00
24	Sidewalk, Conc, 4 inch	1,300.00	Sft	$ 5.25	$ 6,825.00
25	Detectable Warning Surface, Cast Iron	18.00	Ft	$ 80.00	$ 1,440.00
26	Curb Ramp, Conc, 6 inch	60.00	Sft	$ 7.50	$ 450.00
27	Gate Valve and Box, 8 inch, Modified	1.00	Ea	$ 2,500.00	$ 2,500.00
28	Water Main, DI, 8 inch, Tr Det G, Modified	330.00	Ft	$ 145.00	$ 47,850.00
29	Sewer, CI IV, 12 inch, Tr Det B	330.00	Ft	$ 80.00	$ 26,400.00
30	Dr Structure, 48 inch dia	1.00	Ea	$ 3,000.00	$ 3,000.00

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31	Dr Structure Cover, Type K	1.00	Ea	$ 825.00	$ 825.00
32	Sign, Type III, Rem	1.00	Ea	$ 15.00	$ 15.00
33	Post, Steel, 3 pound	15.00	Ft	$ 7.50	$ 112.50
34	Sign, Type III A/B	9.00	Sft	$ 20.00	$ 180.00
35	Pavt Mrkg, Ovly Cold Plastic, 24 inch, Stop Bar	15.00	Ft	$ 10.00	$ 150.00
36	Pavt Mrkg, Ovly Cold Plastic, 6 inch, Crosswalk	55.00	Ft	$ 2.50	$ 137.50
37	Barricade, Type III, High Intensity, Double Sided, Lighted, Furn	5.00	Ea	$ 135.00	$ 675.00
38	Barricade, Type III, High Intensity, Double Sided, Lighted, Oper	5.00	Ea	$ 15.00	$ 75.00
39	Minor Traf Devices	1.00	LSUM	$ 9,700.00	$ 9,700.00
40	Plastic Drum, Fluorescent, Furn	25.00	Ea	$ 27.50	$ 687.50
41	Plastic Drum, Fluorescent, Oper	25.00	Ea	$ 2.50	$ 62.50
42	Sign, Type B, Temp, Prismatic, Furn	100.00	Sft	$ 7.50	$ 750.00
43	Sign, Type B, Temp, Prismatic, Oper	100.00	Sft	$ 1.00	$ 100.00
44	Sign, Type B, Temp, Prismatic, Spec, Furn	50.00	Sft	$ 10.00	$ 500.00
45	Sign, Type B, Temp, Prismatic, Spec, Oper	50.00	Sft	$ 1.00	$ 50.00
46	Pedestrian Type II Barricade, Temp	2.00	Ea	$ 125.00	$ 250.00
47	Erosion Control, Silt Fence	200.00	Ft	$ 2.50	$ 500.00
48	Erosion Control, Inlet Protection, Fabric Drop	5.00	Ea	$ 100.00	$ 500.00
49	Slope Restoration, Non-Freeway, Type B	595.00	Syd	$ 5.50	$ 3,272.50
			Construction Subtotal	$	223,545.00
			Construction Contingency, Engineering, Construction Administration	$	67,063.50
			Total	$	291,000.00

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Engineer's Preliminary Opinion of Costs

Project:	Bangor Water Reliability Study	**Project No.:**	23-1791
Client:	City of Bangor	**Client Project No.:**	N/A
Description:	Scope 3: North St Service Transfer	**Project Stage:**	5-Year CIP Planning
Prepared By:	Madelyn Landry, EIT	**Date Prepared:**	8/13/2024
Reviewed By:	Leah Bectel, PE	**Date Reviewed:**	8/13/2024

Item #	Item Description	Quantity	Unit	Unit Price	Total
1	Mobilization Max, 10%	1.00	LSUM	$ 2,900.00	$ 2,900.00
2	Exploratory Investigation, Vertical	25.00	Ft	$ 40.00	$ 1,000.00
3	Subgrade Undercutting, Type II	50.00	Cyd	$ 22.50	$ 1,125.00
4	Masonry and Conc Structure, Rem	5.00	Cyd	$ 150.00	$ 750.00
5	Cement	5.00	Ton	$ 175.00	$ 875.00
6	Maintenance Gravel, LM	100.00	Cyd	$ 25.00	$ 2,500.00
7	Tree, Rem, 6 inch to 18 inch	2.00	Ea	$ 650.00	$ 1,300.00
8	HMA Surface, Rem	35.00	Syd	$ 5.50	$ 192.50
9	Flowable Fill, Non-Structural	2.00	Cyd	$ 200.00	$ 400.00
10	Water Main, Cut and Plug, 2 inch	2.00	Ea	$ 500.00	$ 1,000.00
11	Subbase, CIP	15.00	Cyd	$ 22.50	$ 337.50
12	Aggregate Base, 8 inch	35.00	Syd	$ 13.50	$ 472.50
13	HMA, 13A (2")	4.00	Ton	$ 93.50	$ 374.00
14	HMA, 36A (1.5")	3.00	Ton	$ 95.00	$ 285.00
15	Driveway, Nonreinf Conc, 6 inch	45.00	Syd	$ 42.50	$ 1,912.50
16	Water Serv, Long, Modified	3.00	Ea	$ 2,500.00	$ 7,500.00
17	Curb Stop and Box	3.00	Ea	$ 750.00	$ 2,250.00
18	Barricade, Type III, High Intensity, Double Sided, Lighted, Furn	10.00	Ea	$ 135.00	$ 1,350.00
19	Barricade, Type III, High Intensity, Double Sided, Lighted, Oper	10.00	Ea	$ 15.00	$ 150.00
20	Minor Traf Devices	1.00	LSUM	$ 1,400.00	$ 1,400.00
21	Erosion Control, Silt Fence	150.00	Ft	$ 2.50	$ 375.00
22	Erosion Control, Inlet Protection, Fabric Drop	2.00	Ea	$ 100.00	$ 200.00
23	Slope Restoration, Non-Freeway, Type B	630.00	Syd	$ 5.50	$ 3,465.00
	Construction Subtotal			$	32,114.00
	Construction Contingency, Engineering, Construction Administration			$	9,634.20
	Total			$	42,000.00

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Engineer's Preliminary Opinion of Costs

Project:	Bangor Water Reliability Study	**Project No.:**	23-1791
Client:	City of Bangor	**Client Project No.:**	N/A
Description:	Scope 4: Monroe Street Improvements	**Project Stage:**	20-Year CIP Planning
Prepared By:	Madelyn Landry, EIT	**Date Prepared:**	8/13/2024
Reviewed By:	Leah Bectel, PE	**Date Reviewed:**	8/13/2024

Item #	Item Description	Quantity	Unit	Unit Price	Total
1	Mobilization Max, 10%	1.00	LSUM	$ 58,000.00	$ 58,000.00
2	Exploratory Investigation, Vertical	50.00	Ft	$ 40.00	$ 2,000.00
3	Subgrade Undercutting, Type II	100.00	Cyd	$ 22.50	$ 2,250.00
4	Dr Structure, Temp Lowering	6.00	Ea	$ 500.00	$ 3,000.00
5	Dr Structure Cover, Adj, Case 1	6.00	Ea	$ 650.00	$ 3,900.00
6	Dr Structure Cover, Type Q	2.00	Ea	$ 825.00	$ 1,650.00
7	Dr Structure Cover, Type K	4.00	Ea	$ 825.00	$ 3,300.00
8	Cement	5.00	Ton	$ 175.00	$ 875.00
9	Machine Grading Modified	11.00	Sta	$ 3,500.00	$ 38,500.00
10	Maintenance Gravel, LM	250.00	Cyd	$ 25.00	$ 6,250.00
12	Tree, Rem, 6 inch to 18 inch	10.00	Ea	$ 650.00	$ 6,500.00
13	Hydrant, Rem, Modified	1.00	Ea	$ 650.00	$ 650.00
14	Curb and Gutter, Rem	1,000.00	Ft	$ 12.50	$ 12,500.00
15	HMA Surface, Rem	3,000.00	Syd	$ 10.00	$ 30,000.00
16	Water Main, Cut and Plug, 4 inch	6.00	Ea	$ 1,000.00	$ 6,000.00
17	Water Main, Cut and Plug, 6 inch	2.00	Ea	$ 1,500.00	$ 3,000.00
18	Subbase, CIP	990.00	Cyd	$ 22.50	$ 22,275.00
19	Flowable Fill, Non-Structural	18.00	Cyd	$ 200.00	$ 3,600.00
20	Aggregate Base, 8 inch	3,000.00	Syd	$ 13.50	$ 40,500.00
21	HMA, 13A (2")	325.00	Ton	$ 100.00	$ 32,500.00
22	HMA, 36A (1.5")	245.00	Ton	$ 100.00	$ 24,500.00
23	Hand Patching	25.00	Ton	$ 200.00	$ 5,000.00
24	Curb and Gutter, Conc, Det C4	1,000.00	Ft	$ 22.00	$ 22,000.00
25	Sidewalk, Rem	425.00	Syd	$ 9.00	$ 3,825.00
26	Sidewalk, Conc, 4 inch	3,705.00	Sft	$ 5.25	$ 19,451.25
27	Detectable Warning Surface, Cast Iron	23.00	Ft	$ 80.00	$ 1,840.00
28	Curb Ramp, Conc, 6 inch	150.00	Sft	$ 7.50	$ 1,125.00
29	Driveway, Nonreinf Conc, 6 inch	70.00	Syd	$ 42.50	$ 2,975.00
30	Fire Hydrant, Modified	1.00	Ea	$ 6,000.00	$ 6,000.00

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31	Gate Valve and Box, 6 inch, Modified	1.00	Ea	$ 1,750.00	$ 1,750.00
32	Gate Valve and Box, 8 inch, Modified	3.00	Ea	$ 2,500.00	$ 7,500.00
33	Water Main, DI, 6 inch, Tr Det G, Modified	15.00	Ft	$ 250.00	$ 3,750.00
34	Water Main, DI, 8 inch, Tr Det G, Modified	1,150.00	Ft	$ 150.00	$ 172,500.00
35	Pavt Mrkg, Waterborne, 4 inch, Yellow	2,310.00	Ft	$ 1.00	$ 2,310.00
36	Barricade, Type III, High Intensity, Double Sided, Lighted, Furn	10.00	Ea	$ 135.00	$ 1,350.00
37	Barricade, Type III, High Intensity, Double Sided, Lighted, Oper	10.00	Ea	$ 15.00	$ 150.00
38	Water Serv, Modified	11.00	Ea	$ 1,750.00	$ 19,250.00
39	Water Serv, Long, Modified	8.00	Ea	$ 2,500.00	$ 20,000.00
40	Curb Stop and Box	19.00	Ea	$ 750.00	$ 14,250.00
41	Minor Traf Devices	1.00	LSUM	$ 25,300.00	$ 25,300.00
42	Plastic Drum, Fluorescent, Furn	50.00	Ea	$ 27.50	$ 1,375.00
43	Plastic Drum, Fluorescent, Oper	50.00	Ea	$ 2.50	$ 125.00
44	Sign, Type B, Temp, Prismatic, Furn	200.00	Sft	$ 7.50	$ 1,500.00
45	Sign, Type B, Temp, Prismatic, Oper	200.00	Sft	$ 1.00	$ 200.00
46	Sign, Type B, Temp, Prismatic, Spec, Furn	75.00	Sft	$ 10.00	$ 750.00
47	Sign, Type B, Temp, Prismatic, Spec, Oper	75.00	Sft	$ 1.00	$ 75.00
48	Pedestrian Type II Barricade, Temp	4.00	Ea	$ 125.00	$ 500.00
49	Erosion Control, Silt Fence	500.00	Ft	$ 2.50	$ 1,250.00
50	Erosion Control, Inlet Protection, Fabric Drop	10.00	Ea	$ 100.00	$ 1,000.00
51	Slope Restoration, Non-Freeway, Type B	625.00	Syd	$ 5.50	$ 3,437.50
			Construction Subtotal	$	642,288.75
			Construction Contingency, Engineering, Construction Administration	$	192,686.63
			Total	$	835,000.00

95 West Main Street
P.O. Box 1088
Benton Harbor, MI 49023
T: (269) 927-2295
F: (269) 927-1017
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Engineer's Preliminary Opinion of Costs

Project:	Industrial Park WM Looping: 60th St - IPD to 30th	**Project No.:**	N/A
Client:	City of Bangor	**Client Project No.:**	N/A
Description:	Industrial Park Water Main Looping (60th St)	**Project Stage:**	Scoping
Prepared By:	Dan Bomzer, PE	**Date Prepared:**	8/23/2024
Reviewed By:		**Date Reviewed:**	
Notes:	*Estimate based on 2024 unit pricing*		

Item #	Item Description	Quantity	Unit	Unit Price	Total
1	Mobilization Max, 10%	1	LSUM	$ 132,000.00	$ 132,000.00
2	Misc Removals	1	LSUM	$ 61,000.00	$ 61,000.00
3	Non-Haz Contaminated Material and Disposal	475	Cyd	$ 30.00	$ 14,250.00
4	Machine Grading, Modified	52	Sta	$ 2,000.00	$ 104,500.00
5	SESC Allowance	1	LSUM	$ 10,000.00	$ 10,000.00
6	Driveway, Nonreinf Conc, 6 inch	300	Syd	$ 60.00	$ 18,000.00
7	Traffic Control Allowance	1	LSUM	$ 37,000.00	$ 37,000.00
8	Minor Traffic Devices	1	LSUM	$ 61,000.00	$ 61,000.00
9	Signage Allowance	1	LSUM	$ 7,000.00	$ 7,000.00
10	Slope Restoration	9,500	Syd	$ 7.50	$ 71,250.00
11	Water Main, DI, 8 inch, Tr Det G	5,938	Ft	$ 110.00	$ 653,125.00
12	Water Serv, Trenchless, 1 inch	1,800	Ft	$ 40.00	$ 72,000.00
13	Curb Stop and Box	12	Ea	$ 750.00	$ 9,000.00
14	Gate Valve and Box, 8 inch	10	Ea	$ 3,000.00	$ 30,000.00
15	Hydrant Assembly	16	Ea	$ 7,500.00	$ 118,750.00
16	Live Tap	2	Ea	$ 10,000.00	$ 20,000.00
17	Water Service Connection	12	Ea	$ 2,000.00	$ 24,000.00
18	Bore and Jack, 8 inch	100	Ft	$ 750.00	$ 75,000.00
19	Railroad Flagging and Coordination	1	LSUM	$ 50,000.00	$ 50,000.00
20	Misc Hardscape Repair and Replacement	1	LSUM	$ 25,000.00	$ 25,000.00
			Construction Subtotal:	$	1,592,875.00
			Professional Services and Contingency (30%):	$	477,862.50
			Construction Total:	$	2,070,737.50