STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
UPPER PENINSULA DISTRICT OFFICE

GRETCHEN WHITMER
GOVERNOR

LIESL EICHLER CLARK
DIRECTOR

April 1, 2019

The Honorable Marcus Muhammad
Mayor of Benton Harbor
200 East Wall Street
Benton Harbor, Michigan, 49022

WSSN: 00600

Dear Mayor Muhammad:

SUBJECT: City of Benton Harbor (ACO) Compliance Schedule

The Michigan Department of Environmental Quality (MDEQ), Drinking Water and Municipal Assistance Division, Order Number ACO-399-07-2019 was made effective on March 5, 2019, with several action items to be completed by the Owner on or prior to dates, as specified within Section II – Compliance Schedule of the ACO. Four of those items are listed below and are the subject of the Compliance Schedule Extension Request.

- **Section 2.2 - Finish upgrades to the supervisory and data acquisition (SCADA) system to store/access regulatory data and ensure alarms and callouts for high turbidity and low chlorine.** The City requests that this due date be adjusted from April 1, 2019 to May 15, 2019.
- **Section 2.3 - Install metering capability on the finished water pipe**. The City is requesting that the due date for this be adjusted from April 1, 2019 to June 15, 2019.
- **Section 2.4 - Have a working chlorine analyzer on the finished water tap**. The City is requesting that the due date for this be adjusted from April 1, 2019 to May 15, 2019.
- **Section 2.5 - Hire a dedicated licensed operator for the distribution system**. The City is requesting that the due date for this be adjusted from April 1, 2019 to May 1, 2019.

On March 26, 2019, you requested the extensions noted above. The city is requesting these extensions due to delays related to vendor scheduling, equipment procurement/installation, and contract operator negotiations. This letter hereby approves the requested extensions for items 2.2 through 2.5 of the ACO only. This letter does not alter the deadline for the remaining items of the of the ACO.

If you should have any questions or concerns with this letter, or your water supply in general, please contact me at the number listed below.

Sincerely,

Michael Bolf

Michael Bolf, P.E.
Engineering Unit Supervisor
Drinking Water and Municipal Assistance Division
906-630-4107

MB:CW
cc: Mr. Darwin Watson, City of Benton Harbor Manager
Mr. Ernie Sarkipato, MDEQ
Mr. Eric Oswald, MDEQ
Ms. Amy Lachance, MDEQ
Mr. Dave Willard, MDEQ
Ms. Patricia Turbett, MDEQ

Grand Rapids District Office
350 Ottawa Ave NW, Unit 10
Grand Rapids, MI 49503

WSSN: 00600

Drinking Water and Municipal Assistance Division

2018 Water System Sanitary Survey

Benton Harbor Water System



DEQ

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Sanitary Survey of Community Water Supply - Review Summary

Water Supply: Benton Harbor WSSN: 00600
County: Berrien District: 93
Evaluator: Sarkipato Date: 2018

Category	Comment	N/A	NotEv	NoD/R	Rec	Def	SigDef
Source						X	
Construction & Maintenance	*Inspection and clean intake, restart mussel control*					X	
Standby Power	*Conduct dark testing on all generator facilities*				X		
Isolation				X			
Source Water Protection	*Study contingencies if single intake fails.*				X		
Capacity	*monitor head loss*				X		
Treatment							X
Disinfection	*Optimize chlorination to balance CT & DBP formation*				X		
Fluoride	*Install forced air ventilation for saturator*				X		
Phosphate Addition				X			
Softening		X					
Iron/Manganese Removal		X					
Arsenic Removal		X					
Pretreatment	*Coagulant feed needs ample mixing energy to be effective*						X
Filtration (gravity or membranes)	*Filter to waste valves not functioning*				X		
C*T	*Reassess chlorination practices to reduce DBP*				X		
Other	*Finished water meters not functioning, can't determine CT*					X	
Distribution System							X
Interconnections w/ Other WS	*Obtain formal emergency agreement w/ Township*				X		
Hydrants & Valves	*Formalize program to turn valves & flush hydrants*						X
Service Lines & Metering				X			
General Plan				X			
Cross Connections	*Program needs complete overhaul, has been abandoned*						X
Construction & Maintenance	*Aging water main replacement is lacking*					X	
Capacity	*Many areas of low/no fire flow.*						X
Finished Water Storage						X	
Construction & Maintenance	*Reinspection of the elevated storage tank is overdue*					X	
Controls				X			
Capacity				X			
Pumps (All Pumping Facilities)					X		
Construction & Maintenance				X			
Controls	*Install VFD on high service at WTP*				X		
Capacity				X			
Monitoring & Reporting							X
Bacteriological Monitoring				X			
Chemical Monitoring				X			
MOR or Annual Pumpage Report	*Inaccurate information on treated water*					X	
Consumer Confidence Report				X			
Analytical Capabilities	*Fix continuous chlorine analyzer*						X
System Management & Operations							X
Owner Responsibility	*Must commit to timeline for compliance*						X
Capacity Development	*Financial & Managerial Capacity is not met*						X
Reliability Study	*Hydraulic model calibration indicated areas of low flow*				X		
Operations Oversight	*Hire Separate OIC for treatment & distribution*						X
Permits				X			
Operator Compliance					X		
Operator Certification	*Distribution & Treatment need more certified operators*				X		
Technical Knowledge & Training				X			
Security				X			
Emergency Response Plan				X			
Site Security (Fences, Alarms...)				X			
Financial							X
Rates	*Collection of rates is ineffecient and ineffective*						X
Budget & Capital Imp. Plan	*Rates insufficient to cover capital improvements*						X
Other	*SCADA system needs additional functionality*						X

N/A - Not Applicable
NotEv - Not Evaluated
NoD/R - No Deficiencies/Recommendations Made
Rec - Recommendations Made
Def - Deficiencies Identified
SigDef - Significant Deficiencies Identified

BENTON HARBOR SANITARY SURVEY RECOMMENDATION SUMMARY

The recommendations provided below are intended to be a concise summary of the more detailed discussions which are found in previous sections of the report. Page numbers following the recommendations indicate where the subject material is discussed in more detail in the survey. In addition, we have ranked each by priority.

Each recommendation has been ranked one (1) through four (4), where a ranking of one (1) is most critical to complete. A ranking of one (1) indicates that the item is a straight forward requirement of the DEQ (mainly Act 399, but this may include other DEQ Water Bureau programs such as NPDES or Ground Water discharge) and must be completed to comply with our rules. A ranking of two (2) indicates that our department feels that the recommendation is necessary to remain in compliance with our rules or that noncompliance is likely if the recommendation is not pursued. A ranking of three (3) indicates that our department feels that the recommendation would directly improve the protection of public health. Finally, a ranking of four (4) indicates our department feels that the recommendation should be considered by the city to enhance operation and maintenance. **All priority 1 findings must be addressed within a timeline agreed upon by the department of environmental quality due to potential public health impacts.**

#	Recommendation:	Report Pages	Treatment (T), Distrib. (D), Management (M)	Priority
1	**Optimize revenue collection to fund operational and capital needs**	**46, 47**	**M**	**1**
2	**Allocate adequate managerial personnel to address ongoing violations**	**29**	**M**	**1**
3	**Hire separate distribution operator-in-charge**	**38, 39**	**M**	**1**
4	**Work with a financial consultant to assess financial mechanism**	**46, 47**	**M**	**1**
5	Include lead service line replacement in AMP	47	M	3
6	Calculate non-revenue water (i.e. water loss)	4	M	3
7	Plan for contingencies if single intake fails	8	M	3
8	Formalize emergency interconnect agreement with Township	41	M	3
9	**Utilize rapid mixers to achieve better coagulation**	**10, 18**	**T**	**1**
10	**Repair online chlorine analyzer on plant tap**		**T**	**1**
11	**Install or repair existing finished water meters**	**22, 36**	**T**	**1**
12	**Upgrade SCADA system for data access, automation, and alarming**	**22, 33**	**T**	**1**
13	Inspect and clean intake, and add mussel control chemical	32	T	2
14	Filter to waste valves must be fixed and remain operational.	12, 15	T	2
15	Train staff on VFD operation of Low Service Pumps	9	T	2
16	Develop a coagulation model	18	T	2
17	Monitor corrosion indices daily, maintain consistent water quality	30	T	2
18	Fine-tune treatment practices to minimize DBP formation	30, 31	T	2
19	Install forced air ventilation on the fluoride saturator	20	T	3
20	Install variable frequency drives on high service pumps	9	T	3
21	Some filters are non-operational and subtracted from plant capacity	12, 13	T	3
22	Conduct "dark testing" annual on all emergency power.	24	T	3
23	Conduct secondary standard verification on benchtop turbidimeter	26	T	3
24	Shorten length of feed line to turbidimeters to increase data quality	14	T	3
25	**Cross Connection program has been neglected for years**	**48**	**D**	**1**
26	**Develop hydrant inventory, maintenance and flushing plans**	**43, 44**	**D**	**1**
27	**Develop valve inventory and a routine turning plan**	**44**	**D**	**1**
28	**Prioritize water main replacement using the capital improvement plan**	**42**	**D**	**1**
29	Update sample pool and materials inventory per lead & copper rule	30	D	2
30	Evaluate interconnect capacities, pursue formal agreements	32	D	3
31	Inspect elevated storage tank every 5 years, clean as needed	40	D	3

Sanitary Survey Data Form

Basic Data

Name of Supply: City of Benton Harbor

Review Dates: 5/15/2017, 9/18/2017, 12/19/2017, 3/5/2018, 6/21/2018, 8/24/2018

WSSN: 0600

Reviewed By: Ernie Sarkipato, Jon Bloemker, Mike Bolf

Mailing Address:

City of Benton Harbor
200 East Wall Street
Benton Harbor, MI 49022
Phone: (269) 927-8400
Fax: (269) 927-0304

Plant Address

Benton Harbor WTP
601 North Ridgeway Drive
St. Joseph, MI 49085
Phone: (269) 927-8471
Fax: (269) 927-8469

City Officials:

Mayor: Marcus Muhammad

City Manager: Darwin Watson
(269) 927-8400
dwatson@cityofbentonharbormi.gov

Utilities Director: vacant

Operator-In-Charge: Mike O'Malley
(269) 363-0575 cell
momalley@cityofbentonharbormi.gov

Designated Backup Operator: Denny Edwards

Distribution System Superintendent: Stewart Beach

Water Treatment Plant Operators:

	Name	Licenses	Operator ID
1.	Mike O'Malley	F-1, S-1	2634
2.	Denny Edwards	F-4, S-4	4753
3.	Doug Vanderploeg	F-3, S-3	2171
4.	Joe Archibald	F-4	17378
5.	Darwin Watson	S-2, F-4 (exp.)	4710

Backup operator designation??

Retail Customers:	Name	Population
1	City of Benton Harbor	9,970 (2010 census, 2011 adjustment)

SANITARY SURVEY DATA FORM

Wholesale Customers None

Service Population: 9,970 Year: 2011 Basis: census w/ adjustment*

**Overall, the population trends of the City is declining. Reduction of population from the census was justified in 2011 due to the ~144 apartments at Cogic Village being served by the Township, though they are within the city limits.*

Percent Metered: City – 100%

Percent Unaccounted: ~ 40 % (this estimate is not reliable, note lack of finished water meters)

Water System Construction Features & Dates:

1. Water system construction prior to 1914. Old state records indicate well and pumping station at this time.

2. 1927 Water Filter Plant in service

3. 1930 Additional Kelly well installed.

4. 1937 Water softening plant additions.

5. 1949/50 Construction of 12 MGD rapid sand filter plant including 2 upflow pretreatment units. Design by Consoer, Townsend & Associates.

6. 1951 Fluoridation equipment installed.

7. 1954 Remaining four of twelve filters equipped.

8. 1967 Construction of Grand Blvd. and M-139 booster stations and ground reservoir.

9. 1968 Construction of Euclid Ave. standpipe and booster station.

10. 1989/90 Installation of 6 MGD low service pump, chlorination, and chemical feed upgrades, replacement of switch gear, replaced filter valves and controls, plant metering and instrumentation, and customer meters.

11. 1991 New media and underdrains in six of the twelve filters.

12. 1995 Repair of one filter underdrain (#4) and new media and underdrains in two additional filters (#3, #7)

13. 1997 Installation of chlorine connection in new spool piece on raw water intake; new traveling screens.

14. 1997 Security improvements; fencing around plant, exterior lighting on clarifiers and chemical storage building.

15. 1997 New underdrain and media in filter #8.

16. 1998 Warranty work on filters #1, #2, #5, and #6 (new underdrains)

17. 2002 New media in filters #5 and #6.

18. 2005 Replaced all filter influent and effluent valves.

19. 2010 Large-scale DWRF project to include waterplant and distribution improvements. Includes new plate settling basins with inclined plate settlers, filter-to-waste provisions for all filters, rehabilitation of filters 9-12, a backwash lagoon, and conversion from gas chlorine to liquid chlorine.

20. 2011 Benton Charter Township constructs transmission main to separate the Township distribution system from the City.

21. 2013 St. Joseph Charter Township constructs transmission mains to separate the Fairplain neighborhood (St Joseph Twp.) from the City water system.

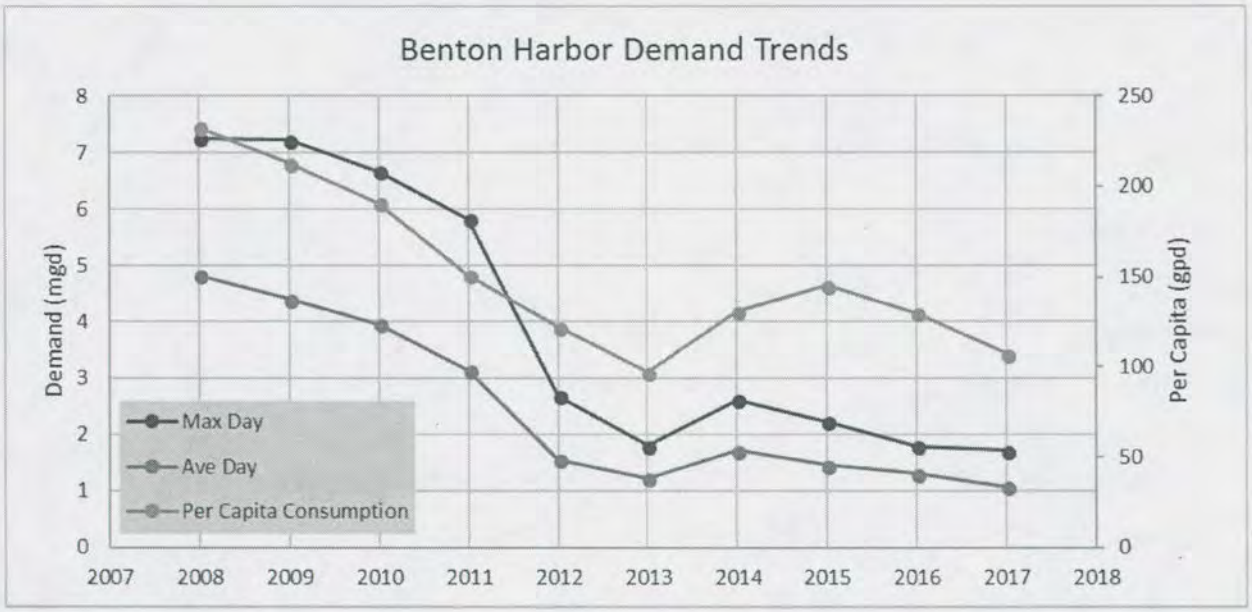
Plant Personnel/Construction/Security Comments: The City of Benton Harbor (City) is classified as an F-1 conventional treatment water plant, and must be attended by an F-licensed shift operator when the water plant is in operation. Plant operation is defined when the plant is treating water to protect public health and operation occurs whenever the low service pumps are running. **The City currently meets the certified operation and oversight requirements in water treatment, and is strongly encouraged to incentivize operators to obtain F-1 licensure.**

Staffing levels at the water plant are insufficient to adequately perform preventative maintenance, and the operator in charge is required to cover operational duties as well as maintenance. A number of simple violations such as reporting violations suggest the operator in charge is unable to spend adequate time on water system management.

The plant is locked during normal business hours. A front door buzzer alerts staff of visitors or deliveries. No trespassing signs are posted in front of the plant, and an entry gate and perimeter fencing has been installed. Security cameras of the water plant grounds transmit to the City police department.

Pumpage Data (Million Gallons)	2008	2009	2010	2011	2012	2013	2014
Maximum Daily Demand:	7.26	7.23	6.67	5.83	2.68	1.80	2.62
Average Day For Maximum Month:	6.11	4.94	4.04	4.21	1.95	1.38	2.17
Average Day Demand For Year:	4.83	4.41	3.96	3.14	1.55	1.23	1.72
Minimum Day Demand	3.2	2.7	2.2	0.11	0.89	0.86	0.15
Average Per Capita Consumption: (gpd)	233	213	191	151	122	97	131

Pumpage Data (Million Gallons)	2015	2016	2017
Maximum Daily Demand:	2.228	1.792	1.72
Average Day For Maximum Month:	1.58	1.515	1.23
Average Day Demand For Year:	1.45	1.3	1.07
Minimum Day Demand	.905	0.834	0.84
Average Per Capita Consumption: (gpd)	145	130	107



Demand Comments: The overall trend for city of Benton Harbor is decreasing. Average day demands have dropped over the past few years, as the City has lost several large industrial users. The Benton Township water plant construction is complete, and Benton Township is no longer a City customer. Further, St. Joseph Township (Fairplain) disconnected from the City and connected their customers to the City of St. Joseph. These separations have resulted in a reduction in the City retail customer population by approximately 35 percent. Even per capita demands have trended downwards, which is an industry-wide trend due to water saving devices and budget-minded consumers. Short term increases in per capita usage could be attributed to large-scale meter replacement, resulting in more accurate readings. **The city should also be determining non-revenue water as a managerial technique. This is done comparing water pumped from the plant to the water billed to customers.**

Water Treatment Plant Capacity

Plant Design Capacity: 12 MGD

State Rated Capacity: 8 MGD

Treatment Classification: F-1

Pumping Capacities:

Low Service	9 MGD
High Service	8 MGD

Pretreatment Capacity 14 MGD

Filtration Capacity: 8 MGD (8 filters @ 1 mgd each)

Plant Metering	Y/N	Type

SANITARY SURVEY DATA FORM

Raw Water:	Yes	two turbine meters
Finished Water:	No	Two 20-inch venturi meters, one 12" mag, **NONE ARE WORKING**
Backwash Water:	Yes	one turbine meter
Plant Water:	Yes	4-inch sensus (type?)

Total Treated Water Storage — MG

Treatment Plant

Clearwell: 30,000 gallons

Ground Storage: 2 MG (two 1 MG abutting reservoirs)

Distribution System

Elevated Storage: 0.65 MG elevated storage tank @ Britain & 8th St.

Total (MG) **2.65 MG**

Percent Of Maximum Day: 50%

Emergency Supply/Interconnections: yes (capacity undefined)
-one interconnection with the City of St. Joseph at M-63 (metered 16-inch main)
-one proposed interconnection with SMRSS&WA at Empire and Woodward (metered 12-inch main)
-interconnections with Benton Charter Township (normally closed and unmetered)

Capacity Comments: After undergoing major renovations to restore the 16 MGD capacity in 2010, the water treatment plant (WTP) was re-rated to 10 MGD in 2015 based on the firm capacity rating of high service pumping and filtration rates. **Currently 4 filters are permanently offline, and with high service pumps 1 & 5 offline since the last survey, the new rating of the water plant is 8 MGD.**

Metering of finished water is not possible at the time of the survey, yet treated water has been reported on the monthly operating reports for years. Finished water meters must be repaired.

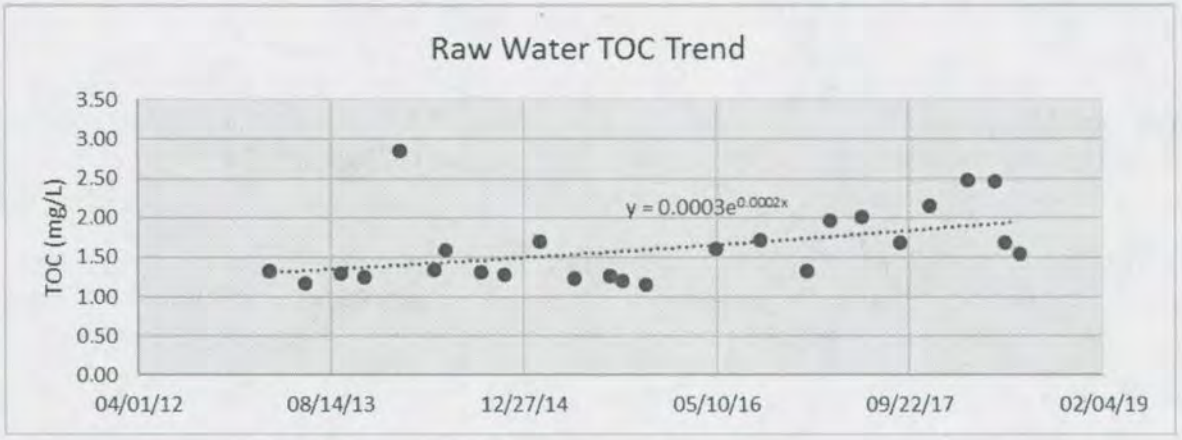
Water Quality

Data taken from the 2013 & 2014 Monthly Operation Reports

	Raw		Treated	
	Normal	Range	Normal	Range
Hardness, ppm	110 - 160	98 - 250	110 - 150	94 - 202
Turbidity, NTU	3 - 6	0.2 - 60	0.11 - 0.12	0.04 - 0.21
Alkalinity, ppm	120 - 160	87 - 182	130 - 150	88 - 172
Total col., cts/100 Ml	0 - 1519	0 - 16000	< 1.1	< 1.1

SANITARY SURVEY DATA FORM

E. coli, cts/100 ml	< 1 - 16	< 1 - 82	< 1.1	< 1.1
TOC, ppm	2.0 - 2.6	1.59 - 3.20	1.5 - 2.1	1.50 - 2.10
Nitrate, ppm	not taken	not taken	0.5	<0.4 – 1.5
Fluoride, ppm	0.12 - 0.24	0.01 - 0.66	0.84 - 1.20	0.03 - 1.88
TTHM, ppb	not taken	not taken	45	37 - 64
HAA5, ppb	not taken	not taken	24	20 - 31
pH	7.9 - 8.1	7.0 - 8.7	7.5 - 7.6	6.8 - 8.2



Comments on Water Quality/Monitoring Requirements:

Lake Michigan is an abundant fresh water source. The intake can be influenced by weather conditions (wind), seasonal turnover, quick thermal changes, and the St. Joseph River. The finished water produced by the plant generally meets all applicable state and federal drinking water standards.

The water plant has no trouble meeting turbidity standards with the addition of the plate settlers. However, runoff conditions and thermal upsets can rapids change and/or degrade source water quality with rapidly changing organics, temperature, and turbidity. In February of 2018 poor water quality led to a spike in filtered turbidity that nearly triggered a treatment technique violation. Several items were identified as necessary improvements to avoid potential violations in the future.

The long term trend appears to be an increasing TOC concentration in the raw water, which requires good pretreatment to achieve adequate removal. The city failed to meet the requirements related to enhanced coagulation, as the running annual average of the treated water rose to above 2.0 mg/L, and the removal ratio running annual average rose above 1.00, resulting in a treatment technique violation with public noticing requirements.

Lake Michigan has a moderate alkalinity concentration that allows stability for coagulant dosages and excellent buffering capacity. Alkalinity levels in both the raw and treated water have seemed to increase by approximately 20 ppm since the last survey, and the hardness has seemed to drop by 20

ppm on average. The slight alkalinity variation does not affect treatment capabilities. The pH does change somewhat in the raw water with limnologic conditions. pH drops during the treatment process slightly (~0.4 units) and the variance seems to follow the lake conditions. The conversion to liquid bleach has resulted in a slightly smaller pH drop during treatment than was experienced using gas.

Natural raw water fluoride levels are characteristic of the Lake Michigan geologic basin and can vary by as much as 0.4 ppm depending on limnologic conditions and influence of the St. Joseph River. This variation can make consistent plant tap fluoride residuals difficult to achieve, but variations are usually adjusted up or down adequately within one day. Fluoride concentration fluctuations do not last long, and at no times has the WTP produced water over 2.0 ppm. Equipment/control failure has historically been common, including one incident of a fluoride release. To avoid working with liquid acid fluoride, a sodium fluoride saturator was installed and is currently running properly.

Occasional positive nitrates occur in source water. It is unknown if there is a strong correlation between spring or local storm run-off and nitrate levels at the intake. The intake has chlorine feed capabilities for zebra mussel control. The intake line has had troubles with clogging from sodium hypochlorite scaling.

The Long Term 2 Surface Water Treatment Rule (LT2SWTR) round 2 requires raw water sampling every two weeks for E. coli, and turbidity, beginning in October 2017. Round 1 sample results placed the City into Bin 1 and no further crypto removal is necessary. It is not anticipated the city will see any surprising results that would change the bin determination.

Odor is not monitored at the water plant, nor are algae counts or algae speciation samples taken.

Intake Facility

Name Of Source:	Lake Michigan
Source Capacity:	Unlimited
Diameter Of Intake Pipe:	36-inch steel
Total Length:	3,950 feet from shorewell
Intake/Crib Capacity:	(24 MGD)
Location (Latitude/Longitude):	N 42^0 07.88' W 86^0 29.10'
Submergence:	3375 ft from shore in 42 ft. of water, 27' to top of crib
Entrance Velocity:	5.25 ft/sec at 24 MGD
Grating:	40 - 2"x12" cedar slats placed radially around opening
Zebra Mussel Control:	3" HDPE leading to diffusion ring in base of intake
Historic Low Water Elevation:	576' above sea level (2013)
Historic Low Water Flow:	no measured change
Historic High Water Elevation:	582.5' above sea level (1986)

SANITARY SURVEY DATA FORM

Intake Facility

Standby (Emergency) Intake?	2 - 36" emergency risers at 1500' and 2500' from shore
Is SWAP Available?	yes
Backflush Provisions?	Yes, from finished water clearwell

Comments on Intake: The intake and two emergency risers were last inspected in 2008. Both the intake and the risers were reported to be in good condition. The riser location (lat/long) should be kept on record in the ERP to access in case of emergency. Although chlorine can be fed at the intake to control zebra mussels, it is not currently employed for a few reasons. The chlorination line has plugged in the past due to scaling, and there is concern over excessive DBP formation. Zebra mussel infestation may reduce the intake capacity somewhat. **Recommend measuring head loss through the intake by comparing the level of lake Michigan to the level in the wet well while the plant is running. Over time, increases in head loss indicate plugging. Additionally, the intake is due for an inspection and likely needs to be cleaned to remove mussels.**

A wet well (~120,000 gals) is located adjacent to the low service pump room. In 1997, a new traveling screen was installed. The motor/gears were replaced in 1999. Also in 1997, a new spool piece was installed on the 36-inch pipe (upstream of the traveling screen) which allows the cone valve (located in a dry well) to no longer be submerged, and allowed the intake line to be back flushed if needed. However, the blow-back valve has been completely removed from service. Piping from the finished water storage can fill the shore well and backflush the intake if needed. The piping is equipped with an air break.

Given the lack of redundancy of a single intake, the City should consider alternative sources of water should the single intake become unavailable.

Pumps and Pump Locations

Purpose		Location	Capacity (MGD)	Type	Lubricant	Status	Preventative Maintenance	Flooding?
Low Service:								
	#1*	plant – 2nd floor	2.0	vertical turbine	oil	active	annually	no
	#2*	plant – 2nd floor	3.0	vertical turbine	oil	active	annually	no
	#3*	plant – 2nd floor	5.0	vertical turbine	oil	active	annually	no
	#4*	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#5	plant – 2nd floor	6.0	vertical turbine	oil	out of service	no	no
	Firm		9 MGD					

SANITARY SURVEY DATA FORM

Purpose		Location	Capacity	Type	Lubricant	Status	Preventative	Flooding?
High Service:								
	#1	plant – 2nd floor	2.0	vertical turbine	oil	out of service	no	no
	#2	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#3	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#4	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#5	plant – 2nd floor	2.0	vertical turbine	oil	out of service	no	no
	Firm		8 MGD					
Filter Backwash:								
	#1	plant – 2nd floor	7.5	vertical turbine	oil	active	annually	no
	#2	plant – 2nd floor	7.5	vertical turbine	oil	active	annually	no
Sludge Disposal:		**by**	**gravity**	**sewer**	**to**	**lagoon**		

Location Of Pump Switch Gear: Located on the second floor and not susceptible to flooding

Comment on Pumps/Pump Maintenance: Low Service pumps take suction from wet well and discharge to rapid mix (24-inch splits to two-20-inch). High Service pumps take suction from finished water suction well which is connected to a 2 MG treated ground storage tank, and discharges to the distribution system via two, 20-inch mains. Backwash pumps take suction from the finished water suction well. (The water plant cannot backwash from the distribution system.) Surface wash pumps take suction from the finished house water line. Most of the Low and High Service pumps have had either the pump or motors rebuilt within the past 13 years. Pump maintenance/overhaul records are kept by plant staff. WTP pump motors have an annual preventative maintenance program by an outside contractor. High service pump # 5 had the foot valve replaced in 2007.

***Low Service pumps have VFD's, yet staff were not trained in their use and were unable to slow treatment during turbidity spikes at the confluence in early 2018. Following communications with the City, staff were trained and are now capable of operating at lower flow rates.**

High Service Pump #1 has been out of service for years, with #5 also having been offline for some time. Without these smaller pumps, the remaining firm pumping capacity of High Service is approximately 8 mgd. The installation of variable frequency drives on the high service pumps would help mitigate the loss of lower capacity pumps, and should allow flexibility in operations to take the elevated storage tank offline for necessary maintenance.

Treatment Facilities

Rapid Mix

Number of Units: 2
Volume of Each Unit: 8600 gallons each
Detention Time at Rated Capacity: 0.5 to 2.0 minutes
Mechanical or Static? Mechanical –variable speed propeller
In-line or CSTR: CSTR

Velocity Gradient (G) if Available? 500 sec-1 (per design engineer, but not currently used)

Is Mixing Rate Adjustable? yes

Condition of Equipment: new

Chemicals Added: Aluminum Sulfate (alum), Capable of adding polymer

Comment on Rapid Mix: As of the 2018 survey, coagulant feed is into the 24" raw water influent without active mixing other than flow velocity. This severely hampers the ability of the treatment plant to combat changes in raw water quality and meet regulatory standards. This is a significant deficiency and must be corrected by constructing a coagulant injection into the pre-designed rapid mix chambers in the new pretreatment building.

Flocculation Basins

Number of Units: 2

Volume of Each Unit: 168,300 gallons each

Three chambered stages, run in series, with adjustable floc paddle speed

Unit Dimensions: 50' x 30' x 15'

Detention Time at Rated Capacity: 40 minutes

Type Of Units: paddle

Inlet Design: baffled

Is Mechanical Flocculator Used? yes

Condition of Equipment: new

Baffles: yes

Baffling Factor: 0.7

Drain: yes

Overflow: none

Curbing: yes

Does A Preventive Maintenance Program Exist? yes

Comment on Flocculation Basins: The new flocculation basins were put into service in 2011. They are three separate mechanical floculation stages and each is 15-feet long. Each flocculator

paddle has a variable frequency drive motor to adjust the paddle speed. Only alum is being used at this time, but the new floc basins have the capabiltiy to treat using polymer as well. At the time of the survey, one motor drive was out of service and awaiting replacement. Settled water quality was excellent.

Settling Basins

Number of Units: 2
Volume of Each Unit: 134,640 gallons each
Dimensions: 40' x 30' x 15'
Detention Time at Rated Capacity: 27.7 minutes at 7.0 MGD
Types of Units: Stainless Steel Plate Settlers at 55^0 inclination
Clarification Rate (gpm/sq. ft.) 0.3 gpm/ft^2
Number of Weirs per basin: one
Total Weir Length: Awaiting as-built drawings
Weir Loading Rate: (gpd/ft)
Inlet Design: baffle wall
Baffles: perforated walls at inlet and outlet
Outlet Design: Effluent Trough Weir
Baffling Factor: 0.5
Overflow: No
Drains: Yes
Curbing: Yes
Sludge Removal Method: scrapers and annual cleaning
Sludge Disposal: Backwash Lagoon – **Needs to be cleaned out**
Physical Condition: new
Effluent Turbidity, average/range: ~ 0.4 - 1.0

Settling Basin Comments: The new plate settlers were constructed under a DWRF project to replace the old decrepit Accelators, and produce settled water that is less susceptible to thermal inversions. The existing raw water piping was rerouted into the new settling basin building from the old plant. A by-pass valve exists around the settling basins. The raw water enters the rapid (flash) mixing chamber, then the 3 flocculation stages. Baffles exist for the inlet and outlet of each flocculation stage. Floc paddle speeds are adjustable by variable frequency drive motors. The water then enters the settling basins filled with plate settlers. The effluent flow then leaves the settling basins over the weirs, where it is piped back to the existing filter building.

Basins can only be operated in parallel or one at a time (not in series). Basin sludge is collected in the sloped floor where scrapers collect it and it is discharged a newly constructed backwash lagoon.

There is a continuous reading turbidimeter on the common effluent pipe from both basins. One settling train was out due at the time of this survey, due to a motor repair. The settling basins have only been in operation a few months, but treated water exceptionally well during a rare period of very poor raw water quality.

Maintenance on the floc/sed basins is currently needed. Exposed metal is rapidly deteriorating due to the humid environment and presence of chlorine. The water system will need to budget for an overhaul within 10 or 20 years.

Filtration

Type of Filter: declining rate, constant head

Dimension of Each Filter: 18 ft 8 in x 18 ft 8 in

Filtration Area: 349 ft^2

Total Filtration Area: 4,200 ft^2

Number and Area of Filters: 12 filters total, each has 349 ft^2 of surface area

NOTE: Filters 1, 2, 3, & 4 were out of service at the time of the DEQ inspection

Design Filtration Rate, gpm/ft^2: 1MGD per filter (2 gpm/ft^2)

Approved Filtration Rate, gpm/ft^2: 4 gpm/ft^2 on clean filter, 2-2.5 gpm/ft^2 over entire filter run

Maximum Experienced Filtration Rate, gpm/ft^2: 4 gpm/ft^2

Is Flow Equalized Through All Filters? yes

Rate Of Flow Device: yes, rate is limited to 4 gpm/ft^2 by effluent valve in a locked position

Filter To Waste Available? ***Yes, not presently working (valve actuator issues)***

Filter Drain: yes

Filter Hours: Average: 200 Maximum: 200 Minimum: 8

Summer Average ~ 170 hours

Filter Media - Filters No. 9-12 (new)

	Anthracite	Sand	Gravel
Depth – Inches:	<2	21	14
Effective Size (mm):	0.9	0.45-0.55	
Uniformity Coefficient	1.5	1.25	

Filter Media - Filters No. 1-8 (new)

	Anthracite	Sand	IMS cap
Depth – Inches:	6	22	
Effective Size (mm):	0.95-1.05	0.45-0.55	
Uniformity Coefficient	< 1.7	< 1.6	

Date Last Rebuilt or Checked: Filters 3, 4, 7 - 1995, new media and underdrains
Filter 8 – 1997 new media and underdrain
Filters, 1, 2, 5, 6, - 1998, new underdrains

Filters 5, 6 – new media in 2002
Filters 9, 10, 11, 12 – 2011 new underdrains

Underdrain Type: Filter 9-12 Leopold blocks with 1-inch IMS cap
Filters 1-8 Leopold blocks with 1-inch of IMS cap

Curbing: yes; front and back

Filter Overflow: back to settling basins

Surface Wash: Yes (need to observe a b ackwash to verify)

Surface Wash Source of Water: in-plant process (treated) water

Air Scour: no

Depth of Water above Media: 63-inches for old filters, 64-inches for new filters

Filter Performance Records: turbidity records being kept for three years

Turbidimeters

Is There Continuous Turbidimeter For Each Filter? Yes Calibration Frequency: monthly

Is There Continuous Turbidimeter For The Applied? Yes Calibration Frequency: quarterly

Is There Continuous Turbidimeter For Confluence? Yes Calibration Frequency: quarterly

Turbidimeter Used For Combined Compliance: Hach TL2300 Calibration Frequency: monthly

Filter Comments: The number of filters presently offline is due to the water plant's inability to keep up with preventative maintenance. In reality, the capacity of all the filters is not needed. As such, the plant's overall rating will take into account the number of filters that are maintained in good condition and are routinely operated.

Filters are declining rate, constant head and have an effluent valve that is "locked" in position, allowing up to 4 gpm/sq.ft on a clean filter. A spring loaded valve adjustment is located on the filter control panel console where the operators manually initiate the flow rate, usually about 2 gpm/sq.ft. and then adjusted throughout the filter run in order to maintain 2 gpm/sq.ft. as head loss rises.

Filters No. 9, 10, 11, and 12 have been rebuilt with the current DWRF project. The City has replaced all filter influent valves and all 6 filter drain valves (which drains the gullet and media of the entire filter unit).

The on-line turbidimeters are Hach model 1720Es. The plant has two CFE grab sample locations for compliance purposes. The South CFE which includes effluent from Filters No. 3, 4, 7, 8, 11, 12, and the North CFE which includes effluent from Filters No. 1, 2, 5, 6, 9, 10. A single sample tap for both South and North CFE would better represent the effluent from all the applicable filters and reduce compliance monitoring points, however due to buried piping a sampling location is not available.

Feed line length for turbidimeters should be assessed for excessive travel time, which is recommended to be less than 1 minute. Simultaneously, assess the flow rate through turbidimeters periodically to ensure it is within manufacturer's specifications.

SANITARY SURVEY DATA FORM

Backwash:

Average Run Length Time of Filter: ~ 200 hours

Criteria for Backwash: 200 hours or 1.0 gpm/ft² or 0.3 NTU

Source of Backwash Water: clear well (treated water)

Average Duration of Backwash: 5 – 10 minutes, ~45,000 gallons per wash

Maximum Duration of Backwash: 10 minutes

Average Backwash Flow, gpm: 5200 gpm

Maximum Backwash Flow, gpm: 5500 gpm

Maximum Backwash Rate - gpm/sq.ft: 15.7 gpm/ft²

Rise Rate, in/min: - 253.3 in/min (5500/349 = 15.76 x 12/7.48)

Is Bed Expansion Achieved? Filters 1-8 yes, filters 9-12 yes

Loss of Media during Backwash? minimal

Backwash Disposal

Backwash Water Discharge Location: lagoon with overflow to surface water

Is Backwash Water Recycled? no

Associated Problems With Filters:
(Check All That Apply)

Air Binding - occasionally	Media Growth - no
Cementing - no	Media Attrition - no
Gravel Mounding – no	Bacteria Growth - no
Media Loss - little	Uniform Backwash – no, swelling observed
Adequate Backwash Rate - yes	Mudballs - no

Filters 3 & 4 were backwashed during inspection. The spray arm wash did not activate as apparently the control valves did not work. The spray arm direction flags leaked water during the backwash cycle.

Filter Operation Comments: The filters are backwashed at a maximum of 200-250 hours, 1.0 gpm/sq.ft or 0.3 NTU, which ever comes first. The 200 hour-maximum is the most common criteria. Mandatory filter run limits are imposed during difficult treatment times, i.e., filter runs of only 50 - 60 hours if applied turbidities are high. Also, if a filter has over 50 hours of operation and is shut down for any reason, it must be backwashed prior to being placed back in service. The new plate settlers have provided consistent low applied turbidity and improved filter run times.

Air binding used to be a problem until air release valving was installed on the backwash header in the early 1990's.

Recent construction added filter-to-waste piping. The filter-to-waste piping is controlled by 4-inch automatic butterfly valves that dump filtered water into a drain pipe under each bank of filters. The drain pipe then flows onto an air break before entering the backwash drain under the floor. The air break splashes a bit during backwash operation. **Not currently operational due to valve actuator problems.** Fixing the actuators gives the operators flexibility to quickly run a filter to waste.

Backwash water enters the lagoon for evaporation/soil percolation and sludge accumulation. Sludge removal occurs approximately annually. There is an overflow with NPDES permit to the adjacent golf course pond; however the discharge has not overflowed since construction in 2012.

Plant Treated Water Storage/Clearwell

Location: adjacent to the plant

Size: 2 MG total, divided into two 1 MGD halves

Percent above Grade: 0%, completely buried

Low Water Level: 8-feet from bottom

Isolation Capabilities: each section can be isolated and/or by passed

Vents: yes, all screened

Reservoir Baffling: exit wall diffuser, baffling factor = 0.3

Drains: each section has sloped floors with a slump

Overflow: yes, into high service suction well.

Overflow screened: yes

Access Hatches: yes, overlapping tight covers

Alarms: none

Last Inspection: east half, 2004; west half 2008

C*T Applied or Applicability: reservoir not needed to maintain adequate C*T

Comments on Treated Water Storage/Clearwell: Half of the finished water reservoir (east half) was drained and inspected in 2004. Some sand and alum was evident, but overall the reservoir was in good shape. The west half was inspected in 2008, and found to be in good structural shape. Each half of the reservoir is properly vented, and the vents are screened.

The 12-inch isolation valve was recently replaced to allow isolation of the reservoir halves and should be regularly exercised to ensure future operation.

The inlet/outlet valve vaults fill with water, and plant staff pump the vaults out as necessary. The entry hatches were recently replaced with stainless steel hatches with overlapping covers.

The high-service pump clearwell (suction well) is accessed from the basement of the plant. The entry hatch is rusted, holy, and flat with the floor. Surge valves are being removed with the new project. Pipes that dump into the clearwell will remain and be capped. A possible interconnection between the surge piping may allow transmission reliability outside of the plant.

Backwash Lagoon

The current lagoon system was constructed with the large 2010 project, and consists of cells A & B separated by a wall. Each cell has an overflow with adjustable sluice gate, with about 3 feet of depth from overflow to bottom of the cell. The cells are unlined, which has led to some controversy with nearby neighbors claiming influence on the water table and wet basements. A groundwater study has not been completed.

	Cell A	Cell B	Total
Depth (ft)	3	3	
Bottom Area (sf)	5,870	30,930	36,800
Approx. Volume (cft)	17,610	92,790	110,400
Approx. Volume (mg)	0.132	0.694	0.826

Backwash Volume: Approx. 45,000 gallons

The lagoons can easily hold several backwash volumes prior to overflow (as designed), however as solids accumulate there will be less freeboard. Recommend keeping 2 feet of freeboard and cleaning these out annually to reduce potential of overflow to surface water.

Overflow: yes, to surface water to the east (wetland/stream/pond)

Chemical Feed

Chlorine

Chemical Supplied: sodium hypochlorite 12 ½ % delivered by truck load (5600 gallon delivery)

UL/NSF Approved? yes

Standard 60 Max Dose:

Supplier: Alexander Chemical – Michigan City, Indiana 1 800 348-8827

Chlorine Feed Points:

1) intake – intermittent use **(not since 2014)**
2) raw water – low service pump discharge* **(poor condition at time of 2018 survey)**
2) raw water - rapid mixer
3) applied – each settling basin effluent
4) treated – high service pump discharge header* **(trickled into clear well upstream of HSP)**

*normal feed points

Chlorinators

Chlorine Feed Dosage Determination: (gallons liquid chlorine) x (% of available chlorine) x (density)

Million pounds of water pumped

Chlorine Room

Description: Bulk chlorine storage room is located in a separate building south of the plant. Three bulk tanks of 2,800 gallons each are provided. Two tanks are filled per delivery (5,600 gallons). Transfer pumps provide chlorine to two day tanks; a 50 gallon and a 200 gallon. Transfer pump switches are located next to the day tanks and are equipped with "dead-man" operation (switch has to be held in the on position to work). The chlorine day tanks are equipped with scales.

Scales: yes – calibrated at installation

Minimum Days of Storage: ~ 60

Chlorine Safety Features/Summary: (*Check All That Apply*)
("both" indicates both the bulk storage room located in a separate building and feeder room located in plant)

☒ Panic Hardware
☒ Chlorine Leak Alarm ☒ Haz-Mat Team
☒ Inside Access feed room only
☒ Outside Access yes -
☒ Doors Open Outward ☐ Repair Kit
☒ Heater ☒ Ventilation
☒ Window ☒ Air Supply
☒ Scales ☒ Fan Switches

Chlorine Comments:

The water plant recently switched to liquid chlorine. The bulk liquid chlorine feed system consists of three bulk tanks located in the chemical storage building across from the plant. Fill ports are clearly marked. Chlorine concentration (density) is measured and some degradation is seen during the summer months. On March 11, 2014, the chlorine feed was left on overnight while the plant was shut down causing an overfeed. The problem was discovered the next day at plant start-up, but the settling basin volume has prevented the chlorine concentration from exceeding 3.5 ppm.

In order to ensure adequate mixing the finished water chlorination point would be best injected into a pipe. The supply may also wish to assess chlorination practices to focus more chlorination downstream of the pretreatment process, to reduce formation of disinfection byproducts. This must be balanced between meeting required CT for disinfection purposes.

Alum

Chemical Supplied: Liquid aluminum sulfate

UL/NSF Approved? yes

Standard 60 Max Dose: 150 ppm as product

SANITARY SURVEY DATA FORM

Chemical Feed Point: raw water rapid mixer

Supplier: General Alum Corporation

Chemical Feeders:

	Model	Max Feed Rate	Min Feed Rate
1	hydroflo CJ4T1131205014	21.58 gph @ 60 psi	95 ml/min
2	hydroflo CJ4T1131205014	21.58 gph @ 60 psi	95 ml/min

Chemical Feed Dosage Determination: usually raw water and applied water turbidity

Alum Dosage Calculation: done properly

Feeder Calibration Frequency: monthly

Scales? No, tank content is determined by sight glass gauge tube and read in inches

Alum Storage

Bulk Storage: two-3,800 gal tanks

Minimum Days of Storage: 45

Transfer Pumps: 2-Thompson Mag pumps, 3/4 Hp, rated 25 gpm @ 20' TDH

Day Tank: 1-300 gallon tank filled manually by operators

Scales:

Level alarms in bulk or day tanks?:

Spill Protection: yes

Piping Identification: yes

Overfeed Protection: Fill line from bulk storage is air-gapped. Dead man fill switch on day tank.

Alum Comments: The alum feed system is currently injected into the raw water influent pipe, upstream of rapid mix tanks in the new pretreatment building. The mixers are therefore turned off. This does not provide adequate mixing and the supply must apply adequate mixing energy to properly disperse the coagulant.

The City should formalize their historic coagulation practices into a standard operating procedure, and/or develop a coagulation model. In addition, during periods of shifting water quality, the City should conduct jar testing to determine the optimal level of coagulation. The city may also wish to study alternative ferric-based coagulants, as the raw water pH is higher than the ideal condition for aluminum sulfate.

Fluoride

Chemical Supplied: Sodium Fluoride (NaF), 100% powder, 4.05% solution in saturator

Chemical Manufacturer: Prayon

UL/NSF Approved? Yes (UL)

Standard 60 Max Dose: 2.6 mg/l as product

Chemical Feed Point: settled water effluent prior to filters

Chemical Feeders:

Two options exist for the fluoride feed system. The first is the new LMI pump, which can pump directly to the system. This system is preferred by the operators for simplicity, and can meet 0.8 mg/L at a plant flow rate of 3.4 MGD.

The second option is to utilize the day tank and previous chem feed pumps. This will be used if the demand for fluoride is greater than the LMI can provide.

	Model	Max Feed Rate	Min Feed Rate
1	1 LMI C131-419SI	8 gph @ 60 psi	
2	Watson Marlow	30 gpd @ 150 psi	

Chemical Feed Dosage Determination: Fluoride dosage calculations were included in the permit application, and are attached to the appendix of this survey.

Fluoride Dosage Calculation: assume 8.34 lbs/gal, 1gal solution has 0.153 lbs F- ion

Scales: Yes on day tank, no on the saturator. Must use volumetric calculations from flow meter

Overflow: saturator overflow is piped to containment.

Fluoride Storage

Bulk Storage: not used

Minimum Days of Storage: 75 gallons of saturated NaF at 4% solution and 4.5 MGD

4.5*8.34=37.53mlbs/day; @0.81mg/L target dose, need 0.81*37.53 = 30.4 lbs/day solution

At 4% solution strength and 46% F ion and 8.34 lbs/gal, *the volume of solution per day is*

30.4 / 8.34 / 0.04 / 0.46 = 198 gallons / day

For 75 gallons, 75 / 198 * 24 = **9 hours of storage**

Transfer Pumps: One-56 gpm @ 56' TDH

Day Tank: 75 gallons filled manually with air gap

Spill Protection: yes

Piping Identification: yes

Overfeed Protection: yes tied to raw water pumps, and flow switch

Fluoride Comments:

The city has a history of sporadic fluoride addition, partially due to leaks in the bulk tank and malfunctioning of pumping equipment. A new sodium fluoride saturator system was permitted and installed, coming online in March of 2018. While this reduces staff exposure to a corrosive chemical, it introduces a new safety concern in NaF dust when filling the tank. **The system was notified via cover letter to the permit that a forced air ventilation system is strongly recommended, as outlined in 10 States Standards.**

In addition, the LMI pump will not produce enough flow to meet the 5-year max day demand of 4.5 mgd. In the event peak operation is anticipated, operators may fill the day tank to help meet those peaks. However, the 75 gallon day tank holds 9 hours of solution at that flow rate. The water plant may need to find a long term solution when these types of flows be encountered.

Other Chemical Additions

Carbon: none

Polymer: newly installed, not yet operational

Lime/Soda Ash: none

Taste and Odor Control: none

Comments on Other Chemicals: No other chemicals besides chlorine, alum and fluoride are currently used at the plant. The water plant is considering polymer addition for the plate settlers per manufacturer recommendation.

Carbon addition was routine operation prior to installation of the old Accelators in the mid-60's. The feed lines are still installed in the low service line to the clarifiers, but are no longer used.

Plant Piping and Miscellaneous

	Pipe Diameter	Length
Intake Pipe:	36 - inch	
Low Service Discharge:	24 – inch (splits into two 20-inch pipes)	
Settled Water Effluent:	36-inch	
Filtered Water Effluent:	30-inch	
High Service Suction Header:	36-inch	
High Service Discharge:	2 @ 20-inch	
Backwash:	24-inch	
Surface Wash:	4-inch	
Wash Water Drain:	24-inch to 30-inch sewer	
Intake Backflush Line:	12-inch REMOVED FROM SERVICE	
Sludge Drain:	24-inch	
Plant Service to Chlorine Feeders	2-inch	
Plant Service Line:	6-inch	

Do Any Roof Drains or Other Drains Enter Treatment Process? no

Pipe Color Coding: all pipes are currently color coded

Plant Cross Connections And Common Walls:

Filter Gullets? Yes, bottom of gullets is the same elevation as bottom of filter media

Common Walls? None (except for the one in the filter gullets)

Chlorine Feed Room? none

Plant Water RPZ? yes

Chemical Feed Areas? none

Surface Wash? RPZ on surface wash header line

Boiler? Removed from Service 2011

Comment on Plant Piping Miscellaneous: Piping is currently color coded (with flow direction arrows); and rusted pipes, flanges, nuts and bolts either replaced or repaired.

A high service discharge pipe burst in September 2007, flooding the basement. A staff person from the Ductile Iron Pipe Research Association (DIPRA) assessed the failed pipe, and the final DIPRA report stated that the pipe was in sound shape and the failure was due to unusual hydraulic conditions.

RPZ's are tested every year by a certified tester. All hose bibs and slop sinks have vacuum breakers installed and the eye wash stations are protected by the RPZ on the plant water service line. There is no dishwasher in the plant. Dehumidifiers are located in the pipe gallery.

All filter wash hoses are rated for potable water (NSF Std. 61).

A WTP valve program has been started. Valves are being inventoried, cataloged, and turned. An automatic valve actuator is available to staff.

Roof drains once dumped onto the filters but were rerouted along the filter room ceiling to the outside. Occasionally the roof drain pipes will leak, but are immediately repaired.

Plant Metering and Controls

Plant Water: meters for backwash water and in-house water use

Raw Water Metering: 2 - one on each settling basin influent line

High Service Metering: *Not functioning*

Backwash Water: one turbine meter

Plant Controls: Pump operation via SCADA from operation room

Chemical Feed: all rates are manually adjusted

Chlorine: manual

Alum: manual

Fluoride: manual

Chemical Transfer Pumps: manual

Filters: starting and stopping filters is done manually at filter control panel

Filter Backwash: done manually according to pre-determined criteria

Low Service Pumps: manual based clearwell levels (level not to drop below 10')

High Service Pumps: manual based on elevated storage tank levels

Elevated Tanks: levels are maintained according to pre-determined criteria

Security: Plant is fenced on 3 sides and staffed 24 hours a day. Doors are locked at all times.

Flexibility In Operation: Pretreatment units (settling basins) can be bypassed or run individually. Filters cannot be bypassed (plant bypass). Filters are piped in pairs and can only be serviced or taken off-line as such.
The entire finished water reservoir (except suction well) can be bypassed. *(must verify C*T is met in this case)*

Plant Alarms *(Check all that apply)*:

- ☐ Basement Flooding
- ☒ Chlorine Leak
- ☒ Chlorine Supply
- ☒ Low Service Intake Well
- ☒ Pretreatment Basin Levels
- ☒ Elevated Storage Tanks
- ☒ Filter Level
- ☒ High Service Pump Discharge Pressure
- ☒ Pretreatment Sump Pump Failure
- ☐ CFE Turbidity
- ☒ Chemical Tank Levels
- ☒ Main Control System Failure
- ☒ UPS Power
- ☒ Finished Water Reservoir
- ☒ Individual Filter Turbidity
- ☒ Elevated Tank Loss of Signal
- ☐ Intrusion Alarms

Comments on Plant Metering and Controls:

The treated water (high service pump discharge) meters have not been calibrated for many, many years and are no longer working as of 2018. The water being pumped out to the distribution system is currently being determined by subtracting the plant usage water from the raw water pumpage.

SCADA system has been upgraded to include turbidity measurements from individual filters that can be observed by the operators in the control room. As an example, an alarm can sound or trip when turbidity from any filter reaches 0.3 NTU. This will alert the operator, who in turn can take corrective action before an individual filter "trigger" is exceeded. Failure to act promptly in this situation could lead to expensive engineering evaluations required by the Interim Enhanced Surface Water Treatment Rule (as nearly happened in early 2018).

The SCADA system needs to be improved to include better access to data, as was discovered during a high filter effluent turbidity event in 2018. In addition, consider more automation to save staff time in certain areas, allowing more focus on maintenance activities. Last, alarm capabilities should be added to give operators the most warning possible.

Valve Operation:
Are Critical Valves Exercised On A Routine Basis?

Valve Location	Exercised?
Intake Valves	Yes

Intake Backflush Valve	no longer in service
High Service Isolation Valves	Yes
Clearwell Valves	Yes
Influent/Effluent Pretreatment Basins Valving	Yes
Effluent Flume Valve	Yes
Low Service Pump Discharge Valving	Yes

Emergency Power:

The water plant technically has two substation feeds from the grid, however they come together at a dedicated substation next to the plant. The plant also can be powered by an onsite generator with the following specifications:

HP: _____
Fuel Type: _____
Fuel Volume: _____
Length of Operation on 1 tank of fuel: _____

Interruptions in Operation:

In November 2000, the plant lost power for about 6 hours when the dedicated substation located next to the plant (not the 2 substations out in the power grid) failed. During May of 2004, a major city-wide power outage lasted 28 hours. The water plant was without power and the distribution system lost pressure for about 18 to 20 hours in several locations even though the distribution interconnection with the City of St. Joseph was in operation. This incident showed that the water plant did not have a reliable power source from the local utility and the water system could operate effectively during power outages. A dedicated auxiliary generator was installed to operate the water plant in the event of a power outage under a DWRF funded water project.

In 2017, a "dark test" was conducted at the water plant to ensure the generator would run all necessary equipment. It failed to properly start and power the plant, which resulted in some repairs. This exercise should be conducted annually to ensure emergency operations run smoothly.

Laboratory

Parameter	*Method	Calibration	Sample Points	Sample Frequency
Alkalinity	Titration (2320)	monthly	1) raw water 2) applied 3) plant tap	twice daily twice daily twice daily
Chlorine	FAS Titration (4500-Cl F) Online Analyzer CL17* DPD Handheld (4500-Cl G)		1) settled 2) applied 3) filtered 4) plant tap 5) dist syst.	every 2 hrs every 2 hrs every 2 hrs continuously* **w/ bacti sample**
Fluoride	SPADNS (4500 D)	twice daily	1) raw 2) plant tap 3) dist syst.	daily daily w/ bactis
Hardness	EDTA titrimetric (2340 C)	monthly	1) raw 2) plant tap	twice daily twice daily
pH	electrode (4500 B)	twice daily	1) raw 2) applied 3) plant tap	twice daily twice daily twice daily
Temp.	elec. thermometer	monthly	1) raw 2) plant tap	continuously twice daily
HPC	Pour Plate (9215B)	monthly	1) raw 2) Plant tap	daily daily
Turbidity	Hach 2100p Hach 2100p Hach 1720E Hach 2100p Hach 2100p	monthly monthly monthly monthly monthly	1) raw 2) applied 3) ind. filter 4) CFE 5) Plant tap	every 2 hours every 2 hours every 10 mins every 2 hrs grab every 2 hrs grab
Coliform	MTF on Raw, Tap colilert on dist. sys (9223 & 9221)	monthly QA/QC	1) raw 2) plant tap 3) dist sys	daily daily per plan

Numbers in parentheses refers to AWWA Standard Methods number

There are continuous monitoring turbidimeters on the low service discharge (raw) and combined settled effluent which are read every 2 hours. Continuous monitoring turbidimeters are located on each of the operating filter effluent lines which record turbidity levels every 15 minutes to a database.

Laboratory Certification: Lab is certified for Total Coliform, *E. coli* and HPC analysis.

Comments on Laboratory:

Online chlorine meter was not functioning at time of survey, resulting in a violation of Act 399 Rule 720(3)(a). In addition there are the following recommendations:

1. The newly purchased benchtop turbidimeter has an internal calibration verification done daily, **however the operators should conduct secondary standard checks periodically as well.**

2. Once a year, all lab equipment is inspected and calibrated in accordance with the QA/QC plan by a third party. **Include the titrator used for chlorine analysis in this calibration.**

3. Consider adjusting the endpoint pH for the expected alkalinity, according to standard methods.

WATER PLANT - OBSERVATIONS, CONCLUSIONS

Basic Data:
The City's Treatment Plant is a conventional treatment plant practicing coagulation, flocculation, sedimentation (via plate settlers), filtration and disinfection. The rated capacity is based on the limiting factors of high service firm capacity and maximum approved filtration rates. At the time of the survey, ***two filters were not operational, nor was low service pump #5 (6.0 MGD) and high service pump #1 (2.0 MGD), yielding an effective treatment rate of 10 MGD.***

The majority of the plant was constructed in 1950, with several improvement projects completed since the original plant went on-line. The City recently improved treatment by constructing plate settlers in two separate treatment trains, installing filter-to-waste piping, rehabilitated filters 9 – 12, and installed a stand-by generator that can operate the entire plant during interrupted utility power. The City also constructed a backwash lagoon for backwash disposal, and converted to liquid chlorine from gas for safety reasons. Most recently, the City switched from fluorosilicic acid to sodium fluoride by installing a fluoride saturator, again largely for safety reasons.

The plant process description starts with raw water flowing via gravity from the intake to the low service wet well, where low service pumps lift the water (after flowing through traveling screens) to the two parallel flocculation basins and settling basins. Liquid chlorine is injected at the low service pump discharge line and alum is added in the same discharge pipe prior to the flocculation tanks and settling basins. **As of 2018, the rapid mix chambers are not being used.** The settling basins

provide sedimentation through inclined plate settlers. Fluoride is added to the settled water which then flows to the filters. Filtered water then flows via gravity to a 2 million gallon finished water reservoir. High service pumps then pump treated water from a suction well which is adjacent to the reservoir, where chlorine is added again before being sent to the distribution system.

The old the pretreatment units (clarifiers) have been removed from service and replaced, hopefully eliminating the plant's vulnerability to thermal inversions. Good success has been achieved by similar plate settling installation at other Lake Michigan water plants.

Rules and Regulations: Since the late 1980's the Federal Safe Drinking Water Act has been amended several times to include rules that specifically apply to water plants using surface water or groundwater under the direct influence of surface water. These rules and the years they were promulgated are:

- Surface Water Treatment Rule (SWTR) - 1989
- Interim Enhanced Surface Water Treatment Rule (IESWTR) - 1998
- Filter Backwash Recycling Rule (FBRR) - 2001
- Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) - 2002
- Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) - 2005

These rules and subsequent rules promulgated by the DEQ under the authority of the Michigan Safe Drinking Water Act, 1976 PA 399, as Amended, require the following of surface water treatment plants:

1. Maintain a disinfectant residual through the treatment process sufficient to inactivate Giardia and viruses. As currently operated, the plant complies with disinfectant residual contact time (C*T) requirements. The C*T calculation was updated as part of this survey to include the extra detention time in the settling basins. The C*T calculation was updated with new and revised parameters related to source water and chlorination practices. Current C*T calculations are included in Appendix C.

2. Rule 325.10720 requires that a residual disinfectant concentration entering the distribution system be no less than 0.2 mg/L. Water suppliers must report to the DEQ by the end of the next business day if the residual was below 0.2 mg/L. Though the city has been measuring chlorine with a benchtop analysis during operations, they have not maintained the chlorine analyzer to verify chlorine levels during periods of non-operation when the high service pumps operate unattended.

3. As further noted by Rule 325.10720, equipment must be provided to continuously monitor the chlorine residual leaving the plant and minimum values recorded daily. The required equipment is installed, but was found to be operating inaccurately at the time of the survey, and reading below the above required value of 0.2 mg/L.

4. Residual disinfectant in the distribution system measured as total chlorine shall not be undetectable in more than 5 percent of the samples each month, or HPC counts must be no more than 500. Distribution residuals must be measured and reported whenever coliform samples are collected. This requirement is also being met with chlorine.

5. Again, as noted by Rule 325.10720, turbidity determinations must be made at least once every 4 hours on samples representative of filtered water while the plant is in operation. A single monitoring

point at a location containing effluent from all filters, but prior to storage is ideal for compliance purposes. The compliance points are the North Filter Flume (Filters 1, 2, 5, 6, 9, 10) and the South Filter Flume (Filters 3, 4, 7, 8, 11, 12) because piping is not provided such that a single filter confluence sampling tap may be installed. For compliance purposes, turbidity samples are collected from each of these two CFE locations once every 2 hours. Both compliance points must be less than or equal to 0.3 NTU in 95 percent of samples each month, and at no time exceed 1 NTU. On two past occasions, July 2002 and July 2003, the plant has exceeded the 1 NTU requirement. In 2018, poor raw waternearly resulted in exceedance of 95% of samples below 0.3 NTU.

6. Finally, the MSDWA requires that individual filter turbidity be monitored and recorded every 15 minutes. This information must be recorded and maintained for three years to determine compliance with "triggers." The individual filter monitoring is operating and performing satisfactorily, but the data retention system is poorly designed making accessing and displaying the data difficult.

7. The Stage 1 of the Disinfectants/Disinfection Byproducts Rule (DBPR) also became effective January 1, 2002, for surface water plant serving over 10,000 people. This rule reduced the maximum contaminant level (MCL) for total trihalomethanes (TTHM) to 0.080 mg/L and set a MCL of 0.060 mg/L for total haloacetic acids (HAA5). In addition, a maximum disinfectant residual level (MDRL) for chlorine was established. A review of the MORs and chemical sample results indicate that these water quality standards are being met.

8. The Stage 2 DBPR requires MCL compliance at each TTHM and HAA5 sampling location rather than averaging results across the system. The city is following the TTHM and HAA5 sampling protocol specified starting in October, 2013. See below section for details on compliance data.

9. The LT2ESWTR requires *Cryptosporidium* treatment for certain vulnerable plants. Based on the *Cryptosporidium* monitoring completed at the plant from April 2008 to March 2010, the water treatment plant was classified as Bin 1 and does not have to install additional treatment. The city missed a sample for E. coli during the second round, which will result in an extra sample collected beyond what is identified in the approved sample site plan.

REGULATORY SUMMARY:

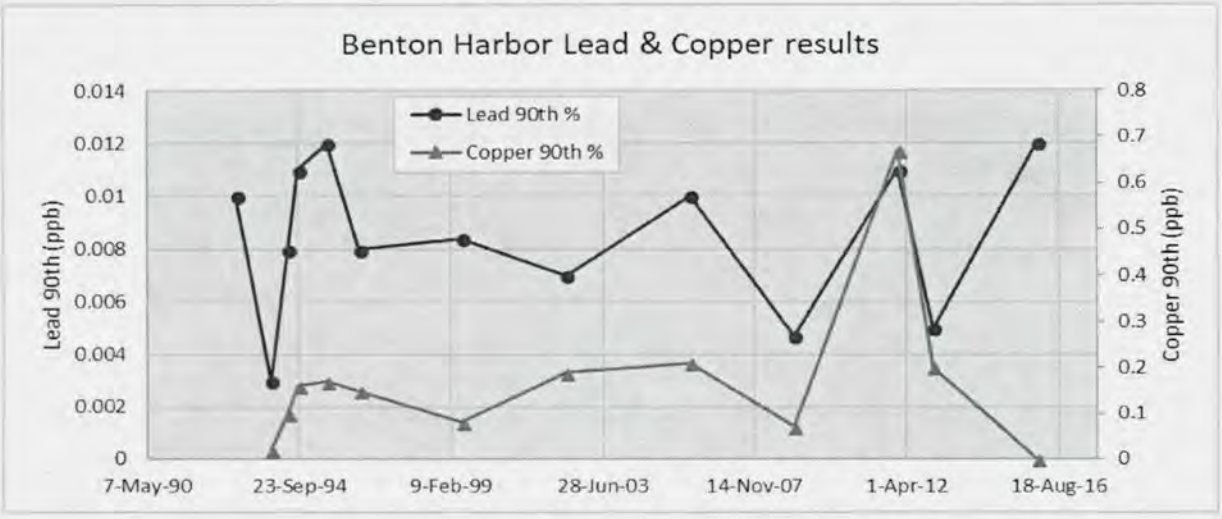
Below is a summary table of violations for the water supply within the last 4 years. The trend appears to be increasing with numerous violations occurring in the last year. Due to the complexity of surface water treatment regulations, significant attention is needed to ensure compliance and protect public health.

Date	Description	Type	Public Notice Required
8/1/2018	TOC monitoring error - thermal	Monitoring & Reporting	Tier 3 (2018 CCR)
7/1/2018	TOC Removal insufficient (continued)	Treatment Technique	Tier 2 (due 9/10/18)
8/1/2018	LT2 - missed E. coli sample, lack of reporting	Monitoring & Reporting	Tier 3 (2018 CCR)
5/19/2018	Failure to issue Public Notice	Monitoring & Reporting	Tier 3 (2018 CCR)
1/1/2018	TOC Removal insufficient	Treatment Technique	Tier 2 (completed, late)
1/1/2017	Missed Samples: Partial Chem, VOC, Cyanide	Monitoring & Reporting	Tier 3 (2017 CCR)
1/1/2016	Missed Sample: TOC	Monitoring & Reporting	Tier 3 (2016 CCR)
10/1/2014	MCL violation for HAA's	Treatment Technique	Tier 2 (completed)

Lead & Copper Rule

Historically, the City of Benton Harbor conducted lead and copper testing as a group with two surrounding townships under an approved modified consecutive systems approach (letter dated 6/18/1993). Each system took a portion of the total 60 samples (BH 38, BCT 12, SJT 10) for the routine monitoring. St. Joseph Township was dropped from the agreement in 1995 due to lack of participation. The City finally became independent when the townships left after Benton Township built a separate treatment facility.

The data indicates a history of 90th percentiles for lead and copper that are under the previously designated action levels of 15 ppb and 1300 ppb, respectively. However, recent revisions in 2018 lowered the lead action level to 12 ppb, which is closer to some of the historic 90th percentiles in the City. The presence of lead in the distribution system is notable, with the majority of the service lines being lead gooseneck with galvanized pipes. The city must ensure they are continually optimizing the treatment system and the distribution system operations to minimize lead release.



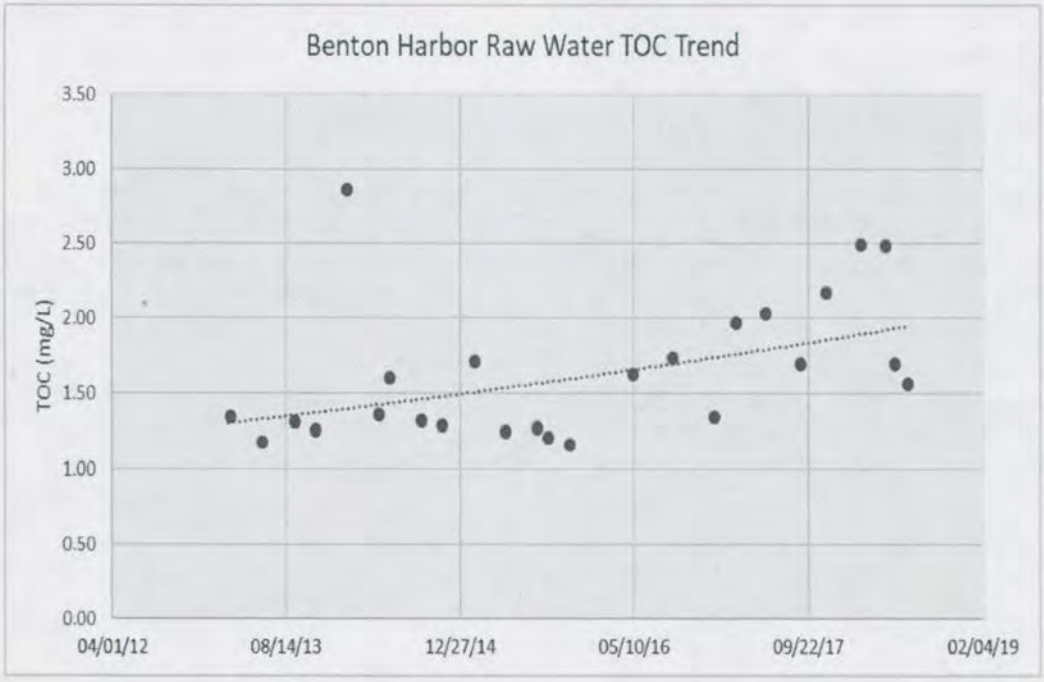
Based on the presence of lead in the historic sample set, please follow these recommendations to an accurate dataset and to mitigate lead exposure:

1. Verify the accuracy of your sample pool.
2. Update the materials inventory.
3. Do not conduct partial lead service line replacement.
4. Avoid any disturbances to service lines.
5. Budget for replacement of lead service lines at 5% or 7% annual rate.
6. Communicate to affected customers about lead exposure, and the importance of flushing
7. Maintain consistent water parameters at the treatment plant, paying close attention to stability indices such as the Chloride to Sulfate Mass Ratio (CSMR), Langelier Index (LI), and Larson-Skold Index (LSI).
8. Many changes occurred in the recent lead and copper rule revision in Michigan. Follow continued DEQ guidance as it becomes available.

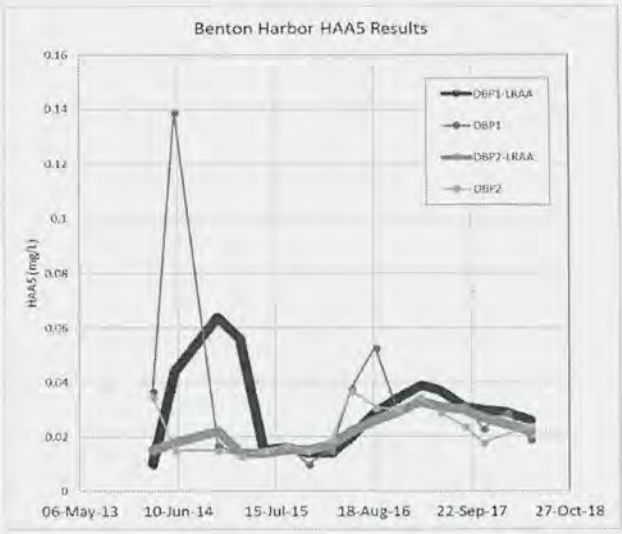
Disinfection Byproducts Rule, Enhanced Coagulation

Disinfection Byproducts form over time in both the treatment plant and the distribution system. The reactions depend on the level of organic matter in the source water, the type and amount of disinfectant used, other water conditions such as temperature, and time.

There are two factors that are in the City's favor: the distribution system is fairly small in areathe source water for Benton Harbor is Lake Michigan, which typically has varying organic content with influence from the St. Joseph River. The data below show a recent increasing trend in TOC in the source water. In addition, there is an increasing trend in disinfection byproducts shown below.







With increasing trends identified in each of these areas, it is vital for the water system to follow these recommendations to minimize DBP formation:

1. Construct adequate rapid mix facilities. This should help remove more TOC and reduce DBP formation.
2. Assess and optimize chlorine feed to minimize reaction with organics, while meeting other disinfection goals such as CT and keeping a residual in the distribution system.
3. Assess and optimize storage tank operations, including set points and potential for stratification.
4. Conduct routine valve turning to help identify closed or broken valves that may be affecting flow through the system.
5. Assess the need for routine flushing if water age and stagnation is suspected in the distribution system. Alternatively, conduct water age modeling using computer software.

Long Term 2 Enhanced Surface Water Treatment Rule (LT2)

LT2 is expected to require Cryptosporidium treatment for certain vulnerable plants. Lake Michigan is not typically suspected to contain high levels of of E. Coli or Crypto, however riverine influences can be significant in certain cases. Following the first round of monitoring, the City was notified of it's Bin classification as Bin 1. The City then began round 2 of LT2 in October of 2017, sampling for E. Coli instead of cryptosporidium.

As a reminder, LT2 sampling must occur outside the presence of disinfectant. In particular, any mussel control feed must be shut down for the sampling.

SURVEY NARRATIVE

Source of Supply:

Lake Michigan has been a consistent source of good quality water for many water treatment facilities. The lake generally has low bacterial and turbidity counts, and fairly low organic content (though it has increased recently). Fluctuations in water quality can be due to either wind & lake turnover, or riverine influence during rainfall/runoff.

There is one interconnection with the City of St. Joseph that will provide some limited reliability in emergencies. Another interconnection has been removed from service. Interconnections exist with Benton Charter Township, and the Township now has it's own source. The amount of water that can be delivered through the existing St. Joseph interconnection is unknown and should be evaluated. The interconnections with Benton Township should be evaluated hydraulically and an emergency use agreement formed. Also, the valves at the interconnections should be exercised annually to make sure they are in adequate working condition.

A source water assessment for the water supply has been completed by the USGS and the DEQ. A final draft report entitled "Source Water Assessment Report for the City of Benton Harbor Water Supply" was completed in the April 2002. The report determined the source water to be "moderately sensitive".

Intake Facility and Wet Well:

The intake draws water 3,375-feet from shore, under about 27-feet of water (from the top of the crib), making it a moderately sensitive intake. There are two, 36-inch diameter emergency risers, located 2,500-feet and 1,500-feet from shore, 23.5-feet and 12.5-feet below the surface, respectively. The capacity of the intake is 24 mgd at an entrance velocity of 5.25-feet/sec. **Lack of zebra mussel control has reduced the intake capacity somewhat, but not enough to interfere with water system demands. This should be measured by checking the drawdown in the raw water wet well, and calculating the head loss through the intake.**

The crib and emergency riser closest to the intake are inspected approximately every other year, with the last inspection being completed in 2007. Both the crib and riser are believed to be in good condition. **The intake should be inspected again soon, and the emergency risers should be located and verified to be accessible during emergencies.**

Chlorine was historically applied at the intake crib via a 3-inch HDPE feed pipe to prevent zebra and quaaga mussel infestation. Mussel infestation is reportedly evident at the intake. No infestation is visible in the wet well. In 1997, a valve and spool piece was installed on the 30-inch raw water line which allowed the intake pipe to be backflushed. However, backflushing of the line has not been necessary, and the valve between the intake and high service line was removed. More recently, the chlorination system has not been used due to plugging. **The chlorination line should be cleaned, and the supply may wish to add a phosphate product to the carrier water in order to prevent scaling.**

The traveling screens in the wet well were replaced in 1997 and new motors/gears for the screens were installed in 1999.

Information and Control System:
Most, if not all of the plant functions are manually operated and/or controlled. The main control room and panels in the plant currently allow operators to adequately control and monitor the plant and distribution system. Alarms are present which will notify operators of potential problems throughout the plant. The main control room has some limited supervisory control and data acquisition (SCADA) systems. Individual filter turbidities measurements are recorded via a SCADA system.

Improvements were identified during the survey in the lack of accessible data through the SCADA system. For instance, a filter profile was difficult to access though it was eventually produced when required. A historian component to the SCADA system should be added to allow for better data retention and access. In addition, more automation may be possible which could allow operators to focus more time on maintenance activities. Lastly, the system should have full alarm capabilities integrated including low chlorine tied to the plant tap analyzer.

The implementation of a preventative maintenance/work order system would also be very helpful to track and organize necessary maintenance. The city has begun to implement CitiWorks for this purpose.

Pumps and Pump Locations:
Proper functioning pumps are essential to the efficient operation of the plant. Pumps that fail to operate, or do not operate as designed, waste operator time and system resources. It is important that the pumps be tested, serviced, and maintained. Detailed records should be kept for these activities. While a majority of the pumps have either had the motor or pumps rebuilt in the past 10 years, a preventative maintenance program should be established for each pump. As a minimum, the plan should include, but not be limited to, all of the following:

1) Basic pump information including the make, manufacturer, pump operating speed, design capacity including pump curves, horsepower of the motor, and pump and motor efficiencies.

2) Actual pump capacity, alone and in combination with other similar use pumps. This information should be recorded and maintained by plant staff so that system demands can be met using the most efficient combination of pumps. This information should be updated at least once per year.

3) A record of all work performed on the pump, including scheduled as well as unscheduled maintenance. The record should indicate the date the work was performed, the nature of the work, and the name of the individual performing the work.

4) An evaluation of the actual current draw for each motor and comparison with original installation or design conditions. Motor efficiencies should be verified at least once per year with appropriate records maintained.

Five low service pumps with a 14 MGD firm capacity lift the raw water from the low service wet well and discharge to a 24-inch pipe which then splits to two, 20-inch pipes that flow to the settling basins. The pump motors and electrical switch gear are located on the second floor of the plant and are above the 100-year flood plain and not subject to flooding. Adequate valving is provided which allows each low service pump to be isolated for maintenance or other purposes. Low service # 5 is out of

service indefinitely. The low treatment demands do not dictate necessity to repair the pump at this time.

Five high service pumps with a 12 MGD firm capacity pump treated water from the finished water suction well adjacent to the treated water reservoir and discharge to two, 20-inch mains that lead to the distribution system. The pump motors and electrical switch gear are located on the second floor of the plant and are above the 100-year flood plain are not subject to flooding. A catastrophic pipe failure in 2005 flooded the basement but the water did not rise enough to affect the switch gear or prevent pump operation. Adequate valving is provided which allows each high service pump to be isolated for maintenance or other purposes. High service # 1 is out of service indefinitely. The low treatment demands do not dictate necessity to repair the pump at this time.

The plant relies on two backwash pumps to backwash the filters. These pumps take suction from the finished water suction well. The backwash rate available from either pump is adequate to clean the filters. These pump motors and electrical switch gear are also located on the second floor of the plant and are not susceptible to flooding.

Pretreatment:
The two circular Infilco Accelators pretreatment basins have been removed from service due to the poor physical condition of the steel and inability to properly prevent floc from entering the treatment train during thermal inversions. Plant pretreatment now consists of rapid mixing (not currently used as of 2018), 3-stage flocculation, baffling, and settling basins with inclined plate settlers. Currently the only coagulant being used is alum, but has the capability to add both polymer and alum. The new pretreatment process has demonstrated the settled water quality to date is excellent.

Filtration:
The plant has 6 filtration units, each with two cells for a total of 12 "filters". For ease of numbering and explanation, the plant is considered to have 12 filters. The filters are declining rate, constant head and each unit has an effluent valve which allows a maximum filtration rate of 4 gpm/sq.ft. The normal or average filtration rate is 2 gpm/sq.ft, which equals 1 MGD for each filter.

Filters No. 9 - 12 underdrains and media have been recently replaced and were out of service at the time of this project. Filters No. 1 - 8 have Leopold filter underdrains with a 1-inch IMS caps that were installed in either 1995 or 1997. New media was installed in Filters No. 3, 4, 7 in 1995, in Filter No. 8 in 1998 and Filters No. 5 and No. 6 in 2002. Filters No. 1 and No. 2 have original media.

The City has replaced all the filter influent and filter drain valves located in the filter piping gallery and has installed filter-to-waste piping for each filter. Also, the paint on the ceiling in the filter gallery has been repainted.

Treated Water Storage:
The 2 million gallon ground storage reservoir consists of two one-million gallon compartments or sections. Each section can be individually isolated or the entire reservoir can be by-passed if needed. Under normal operation, finished water from the reservoir flows to the suction well where the high service pumps then deliver the water to the distribution system.

The east half of the reservoir was inspected in 2004 and the west half in 2008. Both were found to be in generally good shape. All vents, screens and access hatches are in adequate condition and do not allow insects, bugs or drainage water into the reservoir.

Chlorine Feed:
The chlorine feed system consists of bulk liquid chemical storage (three 2500-gallon tanks) located in a separate building and displacement feeders located on the first floor of the plant. Normal application of chlorine is to the low service pump and high service pump discharge lines. Other feed points are available, but rarely used.

The city should assess the chlorination practices to balance the need to meet CT analysis along with the need to minimize disinfection byproduct formation. One potential option is to chlorinate after pretreatment, which would then rely on the reservoir/clear well for CT credit.

Alum Feed:
The alum feed system consists of two 3,800 gallon bulk storage tanks, two transfer pumps, one 300 gallon day tank (no scale) and two chemical feeders and is operating satisfactorily. The transfer pumps are operated manually by a switch within the chemical feed room in the plant. Switch automatically turns off when the day tank float control indicates a full tank.

The alum feed pumps are interconnected with the low service pump circuitry and there is an anti-siphon valve on the discharge line of the feed pump. Normal alum feed point is in the rapid mixer to the new settling basins, but they still can add alum on the raw water line just prior to entering the settling basins. Dosages are manually adjusted by the operators and are calculated by a formula which is based on inches of drawdown in the bulk storage tank via a sight glass. The calculations have been reviewed and appear to be accurate. It may be beneficial to place the day tank on scales to more accurately measure and calculate alum dosages. The day tank overflow drains to surface water. A dead-man switch was recently installed to prevent alum overflow in the event the float control switch fails.

Alum needs to be fed at the rapid mix to impart sufficient energy to disperse the coagulant and achieve effective pretreatment.

Fluoride Feed:
The fluoride feed system consists of an LMI sodium fluoride saturator that utilizes the existing 75 gallon day tank (with scale) and a chemical feed pump. The LMI saturator pump is able to pump direct to the finished water, but is limited in capacity. The operators now have an inhalation risk from the granular NaF during filling of the saturator. **Appropriate PPE is a minimum, but the City should install forced air ventilation as outlined in 10 States Standards.**

The fluoride feed point is on the settling basin effluent line just prior to entering the filters. Dosages are manually adjusted by the operators and are calculated by a formula which is based on scale readings. The calculations have been reviewed and appear to be accurate.

The fluoride feed system has a redundant electrical activation mechanism to prevent over feed. Fluoride overfeeds have occurred at other water plants because of failure of a single electrical activation mechanism. Redundant fluoride feed activation mechanisms must be provided because of the hazardous nature of high concentrations of fluoride. The fluoride feed pumps are interconnected

with the low service pump circuitry. However, a redundant safety mechanism, such as a flow switch must also be interconnected with the feed pump circuitry. This should assure that no chemical feed pumps will operate unless water is flowing and the low service pumps are energized.

Also, anti-siphon valves should be installed not only on the chemical feed pump discharge lines, but also at the point of application to prevent overfeeds from occurring due to siphoning.

Plant Piping and Miscellaneous: The piping within the plant is cast iron and steel. Chemical piping is primarily PVC. The majority of the piping within the plant is rusting, and some severely. Many of the nuts and bolts securing the flanged joints are also severely corroded. While some nuts and bolts have been replaced in the past few years, staff needs to be diligent in replacing these items on a consistent basis. Also, all pipes, drains, and chemical feed lines are being repainted and they will be color coded in accordance with "Recommended Standards for Waterworks, 2007 Edition." Flow direction arrows will also be labeled on the pipes.

The City has recently replaced all the filter influent and filter drain valves located in the filter piping gallery, and recently installed filter-to-waste piping for each filter. The City is encouraged to award the bid to a qualified contractor and proceed with the filter-to-waste project as soon as possible.

Cross connections were found to exist in the chemical feed room and at the filter gullets as a result of the survey. All have been discussed with suggested remedies in other parts of the survey and will not be repeated here.

Plant Metering and Controls: The high service pump meters were out of service at the time of the survey due to construction. Currently, finished water pumpage is calculated by subtracting in-plant water use from raw water meter data. The high service pumps have lacked routine calibration in the past and need to be calibrated routinely.

A routine plant and yard valve exercise program has been started. Each valve has been inventoried and given a number, location, type and function. Each valve should be tagged to identify its function. Plant staff have access to an automatic valve actuator and should be familiar with the location and operation of all yard valves.

Laboratory: The laboratory at the water treatment plant has been certified for analysis of total coliform, *E. coli* and HPC in the past, but the certificate was not on display, and the staff did not know the certification status. The analyses, equipment, and monitoring frequencies have been presented earlier in the report. Since the laboratory is inspected by DEQ RRD, no evaluation of the equipment and procedures currently employed will be undertaken here.

Monitoring frequencies for the various parameters are adequate. Currently, fluoride residual testing in done twice per day. The program for routine disposal of laboratory wastes appears adequate by autoclaving the material and then disposing liquids in the sink and all other material in the trash.

Staff does not test for nor speciate algae or taste and odor. A Quebec colony counter is available for lab staff to use. Staff should be familiar with algae counting and speciation and should perform such routinely.

Treatment Optimization:
It is important to optimize treatment practices to minimize the potential for contamination from microorganisms such as Cryptosporidium and Giardia or other unforeseen contaminants. Appendix D contains a copy of "Recommended Practices for Treatment Optimization". This document prepared by this office in association with industry was provided to all water plants in May of 1995. It is recommended that these practices be studied to determine ways in which treatment may be further optimized. While the details of the document will not be reiterated here, certain practices have proven useful for other water plants. It is hoped that as many optimization practices as possible will be implemented.

Reliability: There are two emergency risers located on the raw water intake line for situations when the crib is unavailable. The riser closest to the intake crib is inspected every other year as part of the biennial crib and intake line inspection. The second riser was located in 2006 and inspected. Bolts on the second riser were replaced.

A generator has recently been installed to provide auxiliary power to the entire water plant during a power outage. It has been exercised and tested and is working satisfactorily. Generator is ran once a month. Fuel is refreshed annually.

There is one metered emergency distribution interconnection with the City of St. Joseph water system. This interconnection can help during emergency pressure problems or to aid during a fire. The interconnection should be defined hydraulically to determine available flow rate. Several connections to the Benton Township distribution exist, but at the time of this survey an emergency interconnection agreement was not in place. The interconnection with St. Joseph Township is proposed to be metered.

At the time of the survey, all controls were working. All adjustments to the chlorine, alum, fluorosilicic acid are made manually by plant operators. Filter backwash is initiated at the filter control console by a plant operator.

Most of the controls, switch gear and breakers are located on the 2nd floor and are not subject to flooding. There is a sump in the basement and a drain through the ceiling in the first floor which leads to surface water. However, certain equipment located in the lower level (all the pumps) may be subject to flooding in the event of a catastrophic pipe/pump failure where if the sump is not capable of removing all the water to prevent flooding.

An update to the previous reliability study was completed in 2017. A hydraulic analysis of the distribution system was included and seemed to indicate the likelihood of closed valves in the water distribution system.

Operators: Although the water plant currently meets regulations and DEQ policy regarding operator certification, we recommend another F-1 operator be provided for to provide additional oversight of plant operations. A dedicated maintenance staff would help extend the useful life of components and equipment in the plant. A separate distribution operator would similarly afford more time and focus on maintaining an old and deteriorating distribution system.

SANITARY SURVEY DATA FORM

DISTRIBUTION SYSTEM

GENERAL

Primary Contact: Mike O'Malley
Title: Utilities Director
Telephone: 269 927 8471
Cell Phone: 269 363 0575
Pager:
Fax: 269 927 8469
e-mail: momalley@cityofbentonharbormi.gov
Mailing Address:
200 East Wall Street

Benton Harbor, MI 49023-0648

Copy To: Darwin Watson
Title: City Manager
Telephone: 269 927 8400 ext. 9
Cell Phone:
Pager:
Fax: 269 927 0304
e-mail: dwatson@cityofbentonharbormi.gov
Mailing Address:
200 East Wall Street
Benton Harbor, MI 49023-0648

Population: 9,970 Year: 2011 Basis: census w/ adjustment*

**Overall, the population trends of the City is declining. Reduction of population from the census was justified in 2011 due to the ~144 apartments at Cogic Village being served by the Township, though they are within the city limits.*

Water Purchased From/Supplier: NO WSSN of Supplier: NA

Operator Certification

Distribution Classification: S-2

Operator-in-Charge: Mike O'Malley	Cert: S-1, F-1	Oper ID: 2634
Designated Back-Up:Demetrius Meeks, DPW Foreman	Cert: S-4 **exp**	Oper ID: 9658
Other Operators: Darwin Watson	Cert. S-2 / F-4 **exp**	Oper ID: 4710
Denny Edwards	Cert. S-4 / F-4	Oper ID: 4753
Douglas Vanderploeg	Cert. F-3 / S-3	
Dennis Hudson	Cert. none	Oper ID: none
Henry Clayton	Cert. none	Oper ID: none
Richard Woods	Cert. none	Oper ID: 18606
Eddie Ellis (meter reader)	Cert. none	Oper. ID: none
Eddie Davis	Cert. none	Oper ID: 13771
Steve Forbear	Cert. none	Oper. ID. None
Patrick Patterson	Cert. none	Oper. ID. None

Comments on staffing: **Additional staff are needed to complete valve/hydrant maintenance and cross connection inspection activities.**

Managing the operations and maintenance of the significantly aging water distribution system requires a full-time operator in charge. The city must secure an operator in charge of the distribution system separately from the treatment plant, based on the number of deficiencies found in the 2018 sanitary survey.

Ownership

Ownership: City – council / manager

Consent Agreement: NA

Escrow Account: NA

Annual Fee: active
Comments: Darwin Watson, City Manager

STORAGE

Construction, Controls & Maintenance

	Location: Britain Street	Location: Water Treatment Plant
Volume	650,000 gal	2,000,000 gal
Type	steel elevated	concrete ground
O.F. Elevation	768.5	above grade
Date Constructed	1938	c 1950
Date Inspected	2008	'04, '08
Date Painted Inside	1991	NA
NSF Std 61 (Y/N)	Yes	NA
	Note: lead primer	
Date Painted Outside	1991	NA
Cathodic Protection	yes	NA
Tank Isolation Valve	yes	yes
Tank Drain (Hydrant)	yes	none
Altitude Valve	yes	no
Mud Valve	yes	
High Alarm	yes	yes
Low Alarm	yes	yes
Chart recorder	SCADA	SCADA
Telemetering System	SCADA	SCADA

SANITARY SURVEY DATA FORM

	Location: Britain Street	Location: Water Treatment Plant
Vents Screened	¼" holes	yes
Overflow Screened	unknown	unknown
Hatches Locked	unknown	yes
Site Fenced/Locked	yes	yes
Capacity		
Usable Storage:	650,000	2,000,000
Total Usable Storage:	2,650,000 gal	2.65 MG

Storage/Max Day: ~ 40% Storage/Avg. Day: ~ 67%

Source of +/- Flows	Amount of flow	
Firm pumping	8 mgd	333,333 gph
Ave Day Demand	1.2 mgd	50,000 gph
3 hour fire 1500 gpm	6.48 mgd	270,000 gph

Based on the above, the high service pumps can push out more flow than a 3 hour 1500 gpm fire would require. Therefore, the volume of storage in the system is not a huge concern. The only remaining issue is then how limiting is the hydraulic transmission in the networks of old 4" pipes. The hydraulic model and reliability study indicates some limitations in this regard.

Storage Comments: Benton Township recently completed water plant and transmission main construction, and the Township is no longer a City customer. This separation has reduced the City customer population by approximately 30 percent. Consequently, the Euclid standpipe and M-139 ground reservoir are no longer available for routine use by the City. Additional elevated storage would be helpful to increase flows and pressures. In the absence of additional elevated storage, an emergency agreement with Benton Charter Township and a hydraulic definition of the St. Joseph interconnect should be obtained to help provide reliable fire protection to the City and the remaining customers.

The 2008 inspection of the elevated storage tank identified necessary maintenance and repairs, including exterior/interior recoating, along with various structural repairs. **While most are not imminently impacting public health, holes in the vent and cathodic caps can allow contaminants to enter the tank and must be repaired.** The tower should be on a regular inspection frequency, and likely is now overdue for a cleaning.

DISTRIBUTION

Interconnections with Other Supplies

Name of Principle Supplier(s)/Wholesaler(s): NA

SANITARY SURVEY DATA FORM

List WSSN number(s): NA

No. of Emergency Connections: 1 (not including Benton Charter Township)

Location	Main Size	Est.Cap.	Metered?	Status (Regular/Emergency)	Connection w/WSSN
M-63	12-inch	unknown	yes	emergency	6310
Main St.	12-inch	unknown	no	out of order	6310
Woodruff & Empire	12-inch		yes	Proposed emergency	6310 & 3726

If emergency, are valves exercised annually? yes

Flushed? no

Comments on Interconnections with Other Supplies: The City is not planning to repair Main Street emergency interconnection. The main was dislodged in a shipping accident under the river and repairs are costly.

The St. Joseph distribution system is on a higher hydraulic grade line than the City, and the City has benefitted from the connection in the recent past. A two-way meter installed in a walk-in chamber along the M63 right-of-way embankment provides the only interconnect at this time. Plans made and a permit obtained to connect the Benton Harbor system with St. Joseph at Empire and Woodruff Streets.

Interconnections with Benton Charter Township exist, but an emergency service agreement does not currently exist between the City and the Township. Without an agreement in place to open the normally closed valves, capacity between the water systems cannot be considered as available.

Distribution Piping

Identify distribution piping materials - estimate percentages:

Cast Iron	80%
Ductile Iron	20%
PVC	0%
AC	0%
HDPE	0%
Galvanized	<1%
Concrete	0%
Lead	<1%

Estimated percent of piping with coal tar lining 10%

Identify distribution pipe sizes - estimate percentages:

2 & 4"	24.2%
6"	33.9%
8"	12.4%
10"	2.0%
12"	16.2%
16"	2.9%
18"	0.3%
20"	8.1%

Main amounts are per Abonmarche 2017 Reliability Study. 345,923 total feet.

Distribution system dates back prior to State program of 1913 (c1890). Earliest state record on file is dated 1914. Water main amounts should be updated with a new general plan as they are revealed. City should plan for elimination of all undersized, galvanized, and lead main.

Due to the sheer amount of undersized cast iron main, the city must prioritize replacement of these old pipes and the lead service lines that are commonly attached to them. Benefits include increased flow and pressure, increased reliability, and reduced exposure to lead.

Operational Concerns & Maintenance

Are there areas where water main breaks are frequent? no

If yes, identify locations: NA

Are there areas where aesthetic water quality complaints are frequent? no

Do you receive complaints alleging illness due to the water? no

Is a procedure in place to respond to and track these complaints? yes

Are there areas where customers complain of low pressure? no

If yes, identify locations:

Comments on Main Breaks, Aesthetic Problems, Complaints: Early 20th Century 2-inch lead main on McAlister Road serves one block and leaks at isolation valve. City needs to replace the rest of small diameter and lead main. All complaints regarding illness from drinking water should be reported to the DEQ.

Are there areas where fire flows cannot be maintained? Yes.

If yes, list locations: Robbins Street, Thresher west of McCord.

SANITARY SURVEY DATA FORM

Last ISO report date? 9/18/1990 Rating: 5

Which, if any, of the above listed areas has the supply prioritized for main replacement, upgrading, or looping? Also, if a definite schedule for capital improvement has been established, list the proposed completion date:

Location:	Estimated Completion Date:
McAlister – replace lead main	unknown

Hydrant replacement program currently out for bid, targets one hydrant in each area.

Comment on Capital Improvements, ISO Rating: Fire flows tested frequently. City intends to pursue project to replace 4-inch main simultaneously with sewer upgrades. Cherry Street and Summit Street are both slated for replacement, upsizing, and looping this year.

Priority should be given to the <500 gpm fire flow sites identified in the 2018 reliability study. However, contrary to the reliability study's recommendation, 6" water main might be the best solution for distribution mains to help maintain lower pipe volume and avoid water quality problems.

Hydrants

Number of Hydrants: 509

Number Without Auxiliary Shut-Off Valves: 30

Number that are Self-Draining: 99%

Number of Inoperable Hydrants: ~100 **some identified from hydraulic modeling calibration, likely many more that are not known.*

Frequency of Hydrant inspection: annually *(flow them annually?)*

Are there areas where additional hydrants are needed? no

If yes, list locations:

Hydrant location system: maps Accurate?

Are hydrants color coded for capacity? yes*

Has this information been provided to the fire department? yes

Frequency and seasons of hydrant flushing: annually ?

Purpose of flushing: maintenance

Is the public notified prior to flushing? no

Does flushing follow a specific format? Yes ?

Is the volume of water used during flushing estimated? no

Is a record maintained of hydrant activities? no

Comments on Hydrants: Significant attention is needed to properly assess, inventory, and maintain the City's fire hydrants. Inability to use a fire hydrant may endanger public safety. Many hydrants are known to have no/low flow, yet investigations into these take time, staff, and funds. To mitigate potential public safety risk and create a path forward to good maintenance practices, the following steps must be taken:

1. **A full assessment and inventory of the City's hydrants is needed.** hydrant number, location of the hydrant, type of hydrant, size of barrel, size of bottom valve, size of lead, direction of turn, operable or inoperable, auxiliary valve type and size, weep holes plugged or unplugged, condition of hydrant (caps, chains, valve operation, operating nut, leakage & etc.), color coded capacity, flow data (gpm & psi), flushing dates, inspection dates.
2. **Develop and implement a routine flushing plan.**
3. **Develop and implement a routine hydrant maintenance plan.**

Valves

Number of Valves: 2,500

Are there areas where additional valves are needed? yes

If yes, list locations: Lake Street area – from Empire to Main Street
Lake Street area – from Colfax to Pipestone

Valve location system: master map & books Accurate? questionable

Valve Turning Frequencies: none

Primary: none

Others: none

Records Maintained? NO

Comments on Valves: Significant attention is needed to properly assess, inventory, and maintain the City's valves. Inability to utilize valves during emergency may endager public health, and closed valves may restrict fire flows which may endanger public safety. The City distribution crew does not turn valves regularly or have a program for such. Several valves (~25) were found closed without record during the Township / City separation transmission project. Similar problems were found during recent winter frost penetration. Closed valves can result in increased power costs and pump wear and tear. **To mitigate potential public safety risk and create a path forward to good maintenance practices, the following steps must be taken:**

1. **A full assessment and inventory of the City's valves is needed.** Information may include valve number, location of the valve, size of pipe/valve, direction of turn, operable or inoperable, condition of valve box (date cleaned, accessible), inspection dates.
2. **Develop and Implement a routine valve turning program to identify closed valves and ensure working condition of known valves.**

SANITARY SURVEY DATA FORM

Customer Service Information

Number of service connections: ~ 3476

Number of metered service connections: 2844 (82%)

City Hall, Police & Fire Station, several Parks unmetered. More unmetered services are being discovered due to poor record keeping.

Identify service line materials and estimate percentages:

Copper:	30 %	
PVC/PE/HDPE:	<1%	
Galvanized:	70 %	
Lead:	? %	**lead services exist but poor records cannot verify amounts**

Ownership of Service (City/Customer)

From Corp Stop to Curb Stop:	City
From Curb Stop to Property Line:	City
From Property Line to Meter:	customer
Meter:	City

Customer Meters

Types of meters Used: Sensus

Meter Testing/Maintenance Program: unknown

Criteria for Changeout: FAILURE

Number or Percent Changeout per Year: ~ 100 (2-3%)

Master Meter Locations: WTP

Calibration of Master Meters: quarterly

% Large Users - List

Whirlpool	175,000 gallons per day

Comment on Metering System: Compound meters are Trident and Rockwell. Several customers have non-working, or old and slipping meters according to staff. Slipping meters may be a large portion of lost water. Water theft and tampering (by-passing) is common. Many water bills are in arrears. Poor customer metering practice in the past has hurt the system. City replaced approx.. 2612 meters using grant dollars.

Water Rates

What is your current rate schedule? $3.80/100 ft³

Are current rates adequate to support O&M and CIPS? ***no***

When was the last time rates were adjusted? 2013

Has a water rate study been performed? 2012 – Abonmarche

Is there a meter charge or ready to serve charge? Yes - 5/8-inch meter $9.03

Is there a capital improvements base charge per meter? Yes – 5/8" is $4.60

Is a copy of the rate schedule and ordinance available? yes

Comment on Water Rates: In 2011, the emergency City manager set up a schedule for rates to increase to cover the cost of inflation, operations, maintenance and replacements to the system, and debt service cost on bonds. In 2013, a different emergency City manager approved a 5% reduction in this rate to reduce the financial burden placed on the residents who were facing economic hardships as the City was in a fiscal position to reduce the rates.

Out of ~3000 water customers in the city, approximately 1100-1200 are notified each month for non-payment. From there, approximately 57 shut-offs are actually done each month which is a significant drain on staff time. In addition, shut-off notices include a $1.00 surcharge to the account.

The city faces a significant challenge in the coming decades relative to funding the operations, maintenance, and improvement of a water system that has been neglected over decades. Current revenues are not sufficient. The collection of water fees is one area for necessary improvement. In order to protect public health, a water system must strive to implement an efficient and effective rate collection system. As part of this, the city council should be educated on the financial outlook of the water system and the importance of revenue collection and paying your water bill.

PROGRAM COMPLIANCE

Asset Management Program

Each AMP should cover 5 elements. Updates should be conducted as necessary, and may be requested as part of an update to the General Plan. A major focus needs to be whether there are gaps in the revenue/rate methodology; in other words, will the water supply have adequate funding to support necessary projects.

The AMP is included in the Appendix to this sanitary survey.

Submitted Date: 2018

SANITARY SURVEY DATA FORM

Asset Inventory Section: Adequate? **Somewhat**. *A detailed description of the Water Plant is included, but offers no clarity on how items are tracked in the AMP. Distribution system is broken down and properly accounted for.*

Criticality Assessment: Adequate? **Somewhat**. Probability of failure was assigned a numerical value based on age and expected life span (for water mains). Consequence of failure also focused on distribution assets, and didn't describe the process for water plant assets. Again, the distribution materials are covered in more detail but the water plant is left vague. Last, *the AMP criticality assessment will soon need to incorporate lead service lines with added priority.*

Level of Service Goals: Adequate? **Yes**.

Capital Improvement Plan: Adequate? **Yes**. The question remains whether the source/treatment plant assets are appropriately ranked relative to the distribution assets. *However, the big picture is there are many items needing attention in both locations.*

Funding/Rate Method.: Adequate? **NO.** Gaps in the operations revenues and expenses were not identified. However, insufficient detail is provided to verify the revenue stream such as rate structure.

Comments:

The AMP must be revised in three ways. *First*, the AMP should give added weight (i.e. consequence of failure) to projects that contain or would eliminate lead service lines (LSLs). *Second*, the city will be required to remove service lines at a certain rate, which may be added as a line item to the finance spreadsheet. *Third*, the program must include specific calculations for operating revenues generated.

Due to the age of the distribution system and sheer volume of assets, this is likely the biggest area for needed improvements. However, continual upgrades at the water plant are also necessary to keep it in good working condition. A good AMP will be able to weight these two categories independently, and prioritize improvements accordingly.

The asset management program concludes that, due in part to water rate reductions in 2013 with claims of affordability, the city may not be able to meet current and future debt payments from capital projects. In fact, a rate increase of 15% could be necessary to close the funding gap simply for current debt. In addition, annual increases of 2.5-6.5% would be needed for the next 4 years, and a 37% increase to fund the 5-year capital project list. **The study finds that a significant increase of the rates over 5 years is needed to pay current debt and to afford necessary capital improvements.**

Given the large amount of capital improvements needed, the city must consider rate increases as inevitable. In addition, with operating budgets so close, there will be foreseeable challenges meeting the requirements of this sanitary survey such as hiring additional staff and incentivizing their development. **To achieve these improvements, the city must prioritize the drinking water system and dedicate the necessary resources to protect public health.** Education of the city council and the general public must be done to stress the importance of investing in the water system through efficient and effective rate paying

Cross Connection Programs

Ordinance No. 44.38 NEED TO SUBMIT A COPY! Date: 6/29/1977

Approved Program? yes Date:

Staff Assigned to Program, (No., Dept and/or who) DPW crew

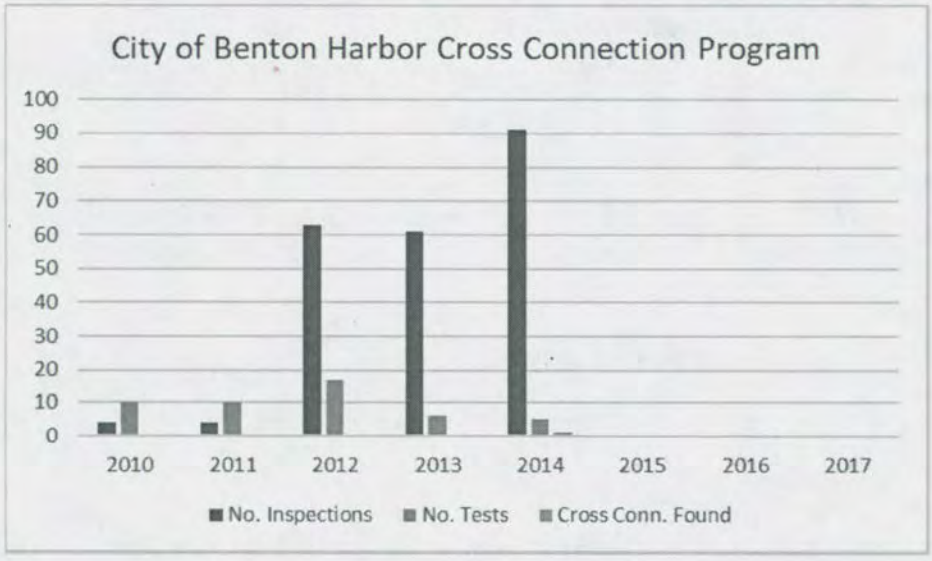
Was previous year's annual report acceptable (Y/N)? missing reports from 2015-2017

Inspection Status: significantly deficient

Device Testing Frequency: significantly deficient

Recordkeeping Adequate? significantly deficient

Comment on Cross Connection Program: Hydro Designs was under contract for cross connection administration until 2009. A couple years of very low inspections occurred from 2010-2011, and from 2012 – 2014 a decent effort was made to inspect and test non-residential accounts.



The lack of staff availability to administer the local program, and failure to do so over the years of 2015 – 2018, has resulted in a significant deficiency. Failure to identify and correct cross connections is an indirect threat to public health.

Monthly Operation Reports

Are Monthly Operation Reports required (Y/N)? yes

Are previous year's reports acceptable (Y/N)? yes

If no, describe problems:

Comment on MOR's: Water usage unrelated to normal demands, such as construction, fire fighting, leaks, tank filling, flushing, should be dated on MOR.

Consumer Confidence Reports

Is the annual CCR required? (Y/N) yes

Was the previous year's acceptable? (Y/N) Yes

Was the previous year's certification form received? Yes Timely? Yes

Comments on CCR:

Emergency Response Plan

Date of Most Recent Plan: 3/1/2005 Acceptable? yes

Filed Where? Water Plant

Comments on ERP: EPA Vulnerability Study and Emergency Response Plan are available.

General Plan

Date of Most Recent Plan: 2017 Acceptable? NO

Filed Where?

Comments on General Plan: Recently updated map as part of DWRF project planning. Hydraulic grade line, flow capacity from interconnect(s), and computer modeling still required. 2008 has several inaccuracies. New requirements due in 2016.

Reliability Study

Date of Most Recent Study: 2017 Acceptable? yes

Filed Where?

Comment on Reliability Study: Hydraulic modeling suggested the city spend time assessing the valves and hydrants in the system to ensure working condition. It also identified many areas with insufficient fire flow that should be replaced.

Permits

Applies for and obtains permits prior to construction (Y/N): yes

Reviews plans prior to submittal to DEQ (Y/N): yes

Standard specifications on file at CWS (Y/N): **2006, needs updating**

Date of Last Master Plan: unknown

Follows master plan for any construction (Y/N):

Actually follows plans as permitted (Y/N): yes

SANITARY SURVEY DATA FORM

Develops as-built plans (Y/N):

Updates general plans (Y/N): Currently updating portions of system maps

Bacteriological

Date of Approved Site Sampling Plan:

Name of Certified Lab Used: City of Benton Harbor Water Treatment Plant 0600

MCL, Monitoring or Reporting Violation(s)? (Y/N) No

Number & Type of Violations in past 12 months: none

Public Notice Issued according to regulations? (Y/N) NA

Bacti Plan Comments: Bacteriological samples are being collected in accordance with the approved Sampling Site Plan (Plan).

Chemical

Date of Monitoring Schedule: 2018

If nitrite detect, what is concentration? 1.5 mg/l

Detects for metals > 50% of MCL? (Y/N) none

Metals (list):

Detects for VOCs (Y/N) only DBPs within range of disinfection

Detects for SOCs (Y/N) none

Date of Disinfection Byproduct Monitoring Plan: Stage I DBP 12/4/01 Stage II DBP 4/19/2010

DBP Sampling Done according to plan? (Y/N)

Lead and Copper Monitoring

No. of Samples Required: 30

☐ Semi Annual ☐ Annual ☒ Triennial

Exceedance of lead or copper action level (Y/N) no

If yes, was public education issued (Y/N) NA

Next Monitoring Period: summer 2021

Corrosion Control Program, if applicable: NA

Lead service line replacement status, if applicable: NA

Chemical Monitoring Comments: The new Michigan Lead and Copper Rule contains many changes and while the new regulation was immediately effective June 14, 2018, it is slated for full implementation by January 1, 2019. Continue to follow DEQ guidance as it becomes available.

Radiological Monitoring

Samples being collected in accordance with the schedule? (Y/N) yes

Alpha, beta, radium, uranium	yes
Radon	NA
Tritium	NA

Detects for Rads > 50% of MCL? (Y/N) no

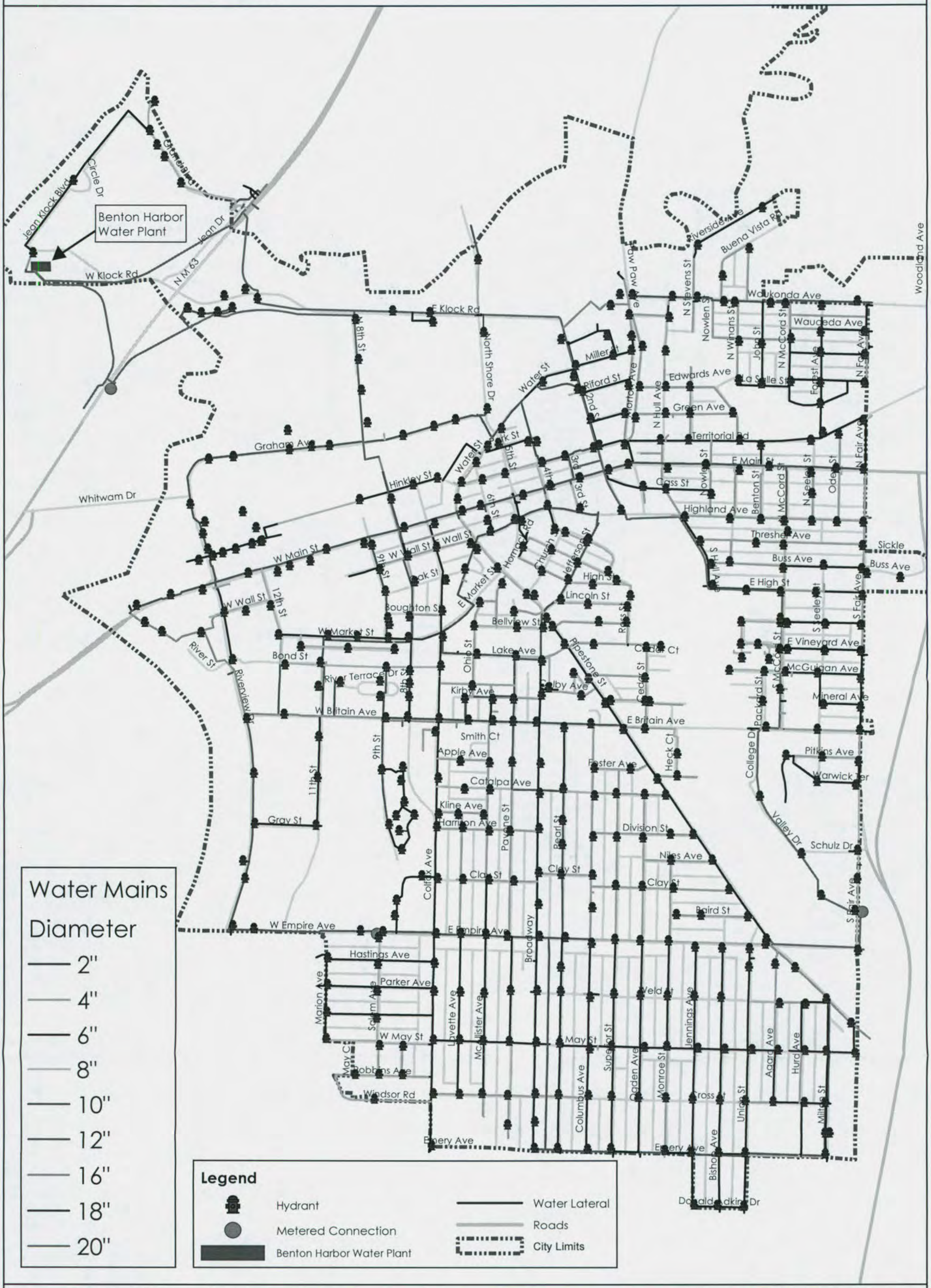
If yes, list:

APPENDICES

APPENDIX A

Plant Flow Diagram

System Map



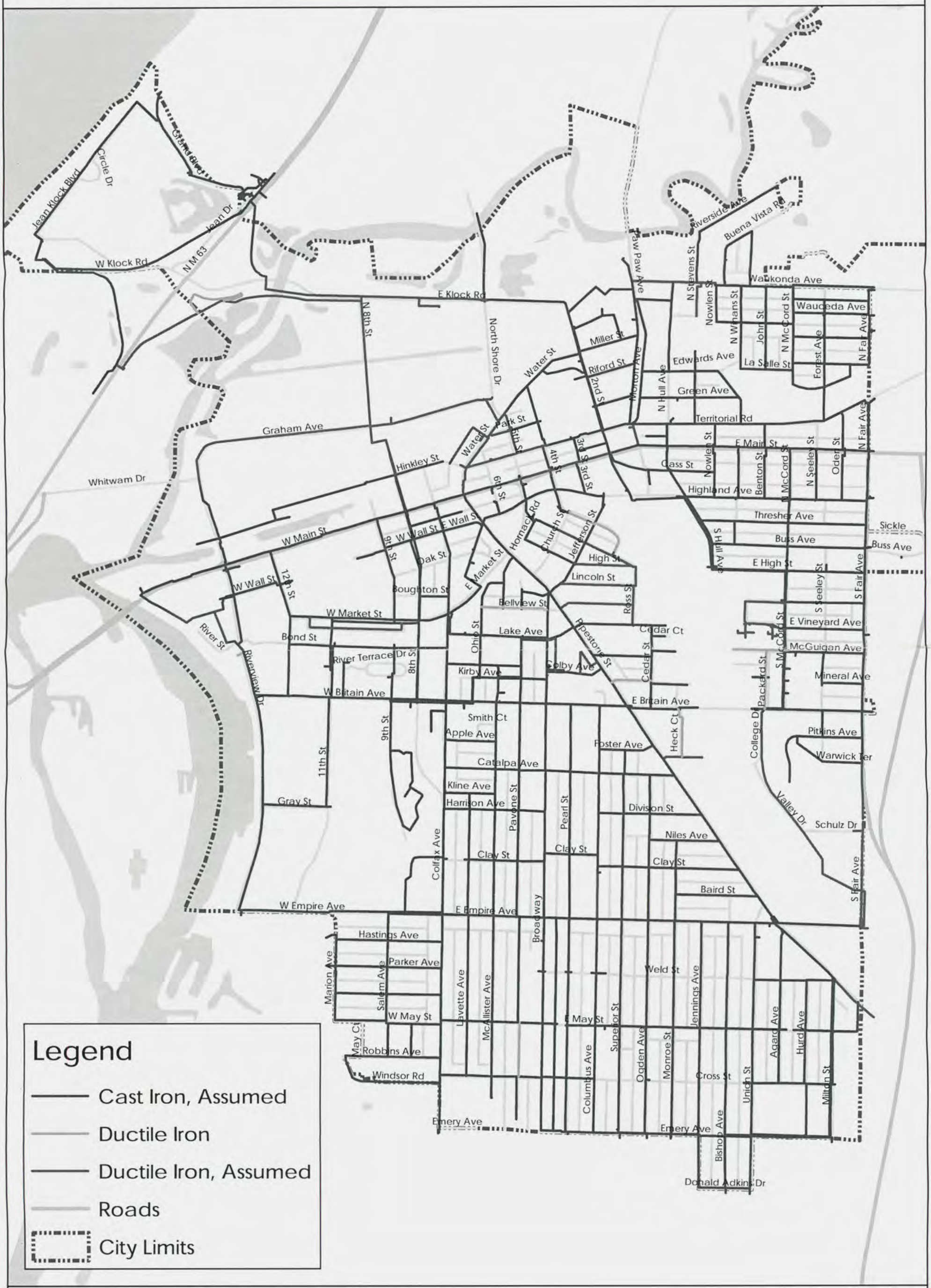
City of Benton Harbor, Michigan

0 0.125 0.25 0.5 Mi

ABONMARCHE

Prepared: March 2018

Water Mains



Legend

- Cast Iron, Assumed
- Ductile Iron
- Ductile Iron, Assumed
- Roads
- City Limits

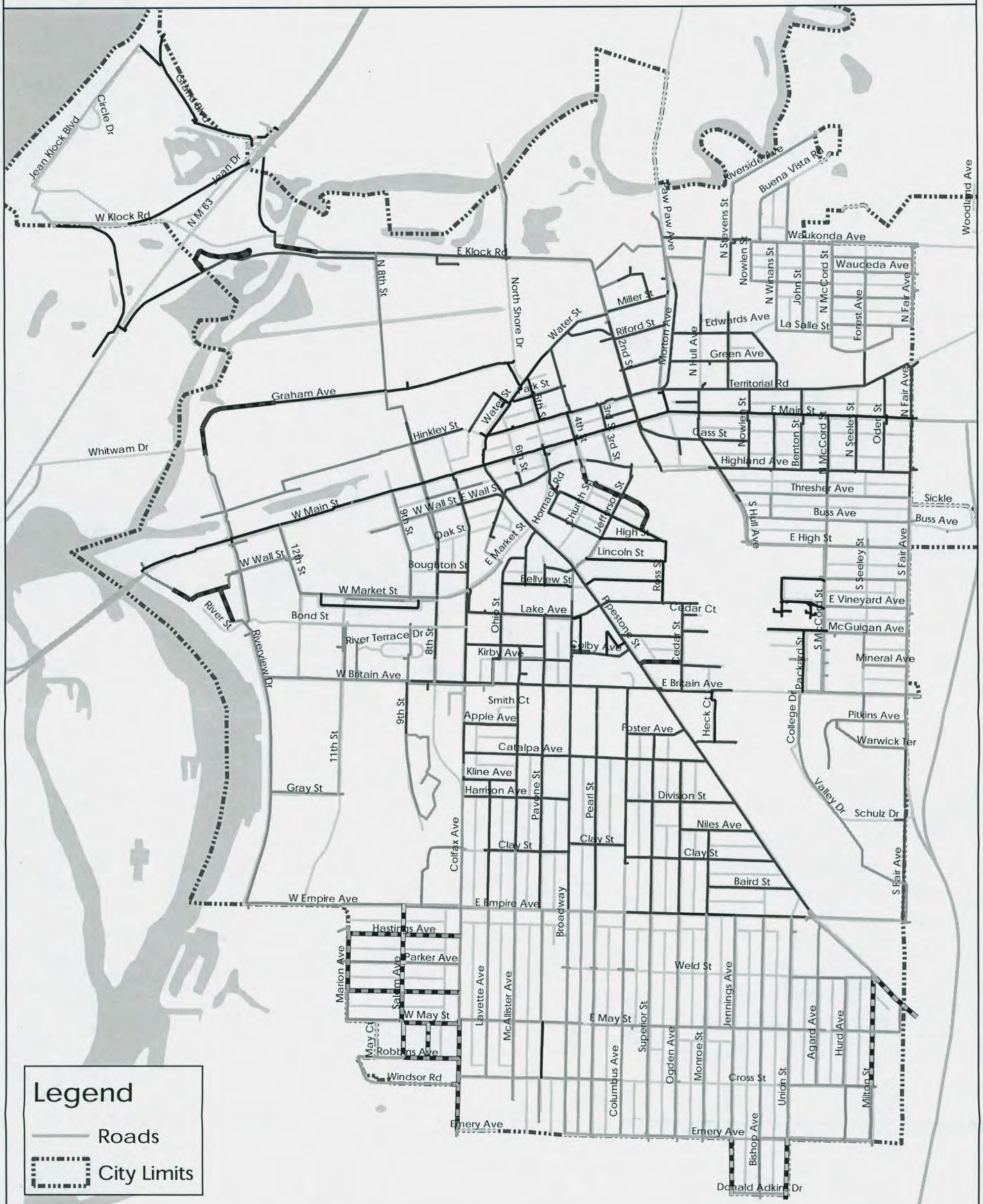
City of Benton Harbor, Michigan

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ABONMARCHE

Prepared: March 2018

Water Mains



Legend

- Roads
- City Limits

Age Year

1900	1950	1980	2000	Pre-1950	Pre-2000
1930	1960	1990	2010	Pre-1960	Pre-2010
1940	1970	1998	Pre-1940	Pre-1990	

City of Benton Harbor, Michigan

0 0.125 0.25 0.5 Mi

ABONMARCHE

Prepared: March 2018



APPENDIX B
Correspondence

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
KALAMAZOO DISTRICT OFFICE

RICK SNYDER
GOVERNOR

DAN WYANT
DIRECTOR

July 16, 2015

Mr. Darwin Watson, City Manager
City of Benton Harbor
200 East Wall Street
Benton Harbor, Michigan 49022

WSSN: 0600

Dear Mr. Watson:

SUBJECT: 2015 Water System Sanitary Survey

On February 26, April 16, and June 16, 2015, the Department of Environmental Quality, Office of Drinking Water and Municipal Assistance, visited the city of Benton Harbor (City) water supply facilities, and met with Utility Director, Mr. Stewart Beach. The purpose of these visits was to evaluate the water system with respect to the Michigan Safe Drinking Water Act, 1976 PA 399, as amended (Act 399); and the rules promulgated, thereunder. Enclosed is our standard evaluation form for your information.

The following table summarizes the findings from our survey of the water system:

Survey Element	Findings
Source	Recommendations made
Treatment	Recommendations made
Distribution System	**Deficiencies Identified**
Finished Water Storage	Recommendations made
Pumps	Recommendations made
Monitoring & Reporting	No deficiencies/recommendations
Management & Operations	Recommendations made
Operator Compliance	Recommendations made
Security	Recommendations made
Financial	Recommendations made
Other	-

We recognize the City made the following water system improvements since the 2011 Sanitary Survey:

- The City has obtained grant money to implement a widespread meter change-out program. Meter replacement is the first step in reducing the approximate 40 percent of unaccounted water amounts. After the meter change-out is completed, please consider the following to further reduce unaccounted water, and increase revenue;

  a. Metering City-owned accounts for record keeping purposes.

b. Having a professional firm perform a leak survey of the distribution system.

c. Develop a long-term, in-house, customer meter testing schedule.

The following deficiencies must be addressed:

A. Rule 1108 of PA 399 states *"Sufficient valves shall be provided on the distribution system to minimize interruptions in service and minimize hazards during construction or repairs."* Rule 1111 says *"A public water supply shall maintain adequate records on the operation of the water distribution system, on the location and type of maintenance performed, and the type of materials and appurtenances used."*

We understand that valves are not properly exercised, valve locations inaccurately mapped, and many valves have been left unrecorded in the closed position. These practices over time can result in an increase head on the high service pumps, and cause greater interruptions during repairs. It is imperative that the City accurately map, exercise, repair, and replace the distribution valves.

B. Rule 1404 requires water utilities to implement an approved cross connection control program. While a handful of inspections have been made recently, the City is still lacking in number of needed high-hazard inspections. DPW staff are also in need of cross connection inspection training, to allow delegation of this important task.

We offer the following recommendations to improve the operation and maintenance of your water supply:

1 Rule 1606 of Act 399 requires that the contents of a General Plan include source, treatment, and auxiliary power capacity, hydraulic modeling, an inventory of pipe by age, size, and material, areas where distribution pressure may fall below 20 p.s.i. during peak flow, and a 5-year and 20-year Capital Improvement Plan by **January 1, 2016**. Enclosed is a summary list of Reliability Study and General Plan requirements. Please review this list with your consulting engineers and update the Reliability Study and General Plan to include the new requirements.

2 One low service and one high service pump was out at the time of our inspection. Please evaluate and repair the necessary pumps and motors.

3 We recommend the City hire a distribution system foreman, to oversee the cross connection program, valve turning, mapping, and other various duties.

4 It has been a while since the City has inspected the intake crib and pipe. Please schedule a comprehensive inspection soon to determine maintenance cleaning needs.

5 The fluoride feed has been inconsistent, often offline for months at a time. We understand the inconsistent feed is due to pump control issues and the fluoride feed is currently operational. Please be aware that consistent fluoridation is necessary for proper customer oral health benefit. The Michigan Department of Community Health is offering grant money to improve fluoridation practices. Please contact Ms. Susan Deming at 517-373-3624, or by e-mail at demings@michigan.gov, to obtain information on a grant application.

6 Please evaluate the performance and energy imparted by the rapid mix and flocculation process as designed (G value) to help determine treatment optimizing. This information may be done in house or hired out.

7 The rotating filter spray wash in filters 3 and 4 was not working properly at the time of our visit. Please evaluate all spray wash apparatus, and repair to ensure proper cleaning during filter backwash.

8 We strongly recommend an interconnection agreement be developed with Benton Township to ensure system reliability during emergencies. Both communities could possibly benefit from such an agreement.

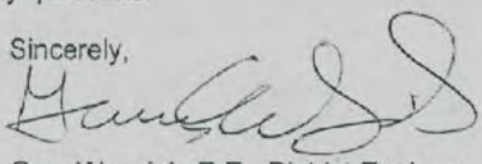
9 Abandoned service lines should be abandoned at the main corporation, and not the curb box. Abandoning service connections at the curb promotes the city-owned portion (goose-neck) to freeze and split, resulting in expensive repairs. Furthermore the city-owned portion may be undersized by modern standards or lead, requiring replacement during future development. Please amend the City standard specifications to require service line abandonment at the main, and inform contractors when bidding.

10 Update the enclosed Emergency Response Plan template to reflect current phone numbers.

11 With the separation of the townships from the City system, we recommend the City plan for increasing elevated storage capacity to provide fire protection. Please discuss with your consulting engineers adding to the elevated storage capacity.

I would like to meet soon and discuss this survey with the City. Please contact me at your earliest convenience at 269-491-3107, by e-mail at wozniakg@michigan.gov, or by mail, to schedule a meeting, and also if you have any questions.

Sincerely,



Gary Wozniak, P.E., District Engineer
Field Operations Section
Office of Drinking Water and
Municipal Assistance

GAW:NKE

Enclosures

cc/enc: Mr. Stewart Beach, Utilities Director, City of Benton Harbor
cc: Susan Deming, Oral Health Coordinator, MDCH
Berrien County Health Department

RICK SNYDER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
KALAMAZOO DISTRICT OFFICE

KEITH CREAGH
DIRECTOR

April 4, 2016

0600

The Honorable Marcus Muhammad, Mayor
Mr. Darwin Watson, City Manager
Benton Harbor City Commission
City of Benton Harbor
Benton Harbor City Hall
200 Wall Street
Benton Harbor, MI 49022

Dear Ladies and Gentlemen:

Subject: City of Benton Harbor Sanitary Survey, Mid-Term

The Department of Environmental Quality (DEQ), Office of Drinking Water and Municipal Assistance (ODWMA) Field Office Staff, performed a Sanitary Survey of the entire city of Benton Harbor (City) drinking water system in 2015. The summary table of our survey is enclosed for your information. The City received a "deficient" rating in areas relating to the water supply distribution system. Since our survey was completed, the status of the distribution system is more concerning, and we wish to formally bring to your attention the following items:

- Two major distribution leaks have been flowing continuously for more than nine months (Union & Cross, Winans & Waukanda). Water leaks are paths for contaminant to enter the water system and can cause further infrastructure damage, waste money in pumping energy, and equate to lost revenue.

- Rule 1108 of Act 399 states "*Sufficient valves shall be provided on distribution systems to minimize interruptions in service and minimize sanitary hazards during construction or repairs.*" Our understanding from contract operator Jay Ouzts, is that valves are not accurately mapped, or are paved over, and enough are broken that the crew cannot isolate the leaks. Plans are being made to shut down a large section of the distribution system to insert valves, and the repairs will cause disruptions in service. Pressure losses are opportunities for contaminants to enter the water system, and will require a boil order until mains are repaired, tested, and placed back in service.

- The recent winters have caused severe frost penetration, and an unusually high number of main breaks and service line leaks. Emergency dig-ups have revealed several lead service lines in locations that were previously unknown. Lead sampling sites must be revaluated to include at least half of the sites to be from lead service lines. Additionally, it is recommended that the City begin developing a plan to identify and replace all lead components in the distribution system, including the privately-owned portion of the service lines, if applicable. Please refer to the recent memo from the DEQ Chief Deputy Director, Jim Sygo, dated March 14, 2016, relating to the lead/copper program.

- It is the understanding of this office that Benton Charter Township serves the Cogic Village apartment population; therefore, decreasing the City population served to 9,670 residents. This change has been documented.

- Our Operator in Charge policy states that a certified operator must be available daily, at least 4-hours a day, and 5 days per week. We understand contract operator Ouzts is available over 20 hours a week, but not daily at the plant. Please be sure the City provides a properly certified operator according to policy.

- A Capital Improvement Plan (CIP) was due on January 1, 2016, that included 5-year and 20-year planning periods. This office received on January 15, 2016, a CIP that only includes a 5-year planning period. Please amend the report to include the additional planning schedule as required by Rule 1606 of Act 399.

Please review these recommendations and contact me by e-mail at wozniakg@michigan.gov, at (269) 491-3107, or by mail, if you have any questions.

Sincerely,

Gary Wozniak, P.E., District Engineer
Field Operations Section
Office of Drinking Water and
Municipal Assistance

GAW:NKE

Enclosures

cc/enc: James Ouzts, F&V Operations
cc: Berrien County Health Department

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
GRAND RAPIDS DISTRICT OFFICE

RICK SNYDER
GOVERNOR

C. HEIDI GRETHER
DIRECTOR

March 14, 2018

Mr. Darwin Watson, City Manager
City of Benton Harbor
200 Wall Street
Benton Harbor, MI 49022

WSSN: **00600**

Dear Mr. Watson:

Subject: Compliance Communication for City of Benton Harbor Public Water Supply

This letter is to address our review of events at the City of Benton Harbor Water Treatment Facility (plant) for the period of February 25–27, 2018. During this time, water quality in Lake Michigan abruptly shifted, resulting in an increase in the levels of turbidity as measured in nephelometric turbidity units (NTU). Operators at the plant took measures to limit the amount of turbidity reaching the filtered water, and successfully met the required maximum level for turbidity. Our review of the event and operations of the water treatment facility was conducted under the authority of the Michigan Safe Drinking Water Act, 1976 PA 399, as amended (Act 399).

High turbidity is used as an indicator of the presence of pathogens such as viruses and bacteria. Increases in turbidity are often seen when snowmelt and runoff conditions occur, which likely contributed to this event. *Our primary concern is the ability of the plant to produce acceptable water quality that is within the regulatory limits, thereby protecting public health.* Rule 611b of Act 399 allows up to five percent of the turbidity samples taken at the compliance locations to be above 0.3 NTU for any month. The water supply met this requirement, with approximately 3.5 percent of samples above this threshold for the month of February. Rule 720a (b) also requires a filter profile to be produced within seven days of a turbidity exceedance above 0.5 NTU. The water supply was eventually able to produce filter profiles, though the computer software at the plant was not capable of quickly producing the profiles onsite.

Due to the nature of this event with high turbidity water being released from multiple filters, a review of equipment and operational practices at the treatment facility was warranted. An onsite review was conducted at the water plant along with Superintendent Mike O'Malley on March 5, 2018. The findings below are cause for concern and need to be addressed:

1. The coagulation chemical, Aluminum Sulfate (or coagulant), is injected via standard injection quill into the raw water pipe. The properly designed rapid mix tanks, next to the flocculation tanks, are not being used. Coagulation theory indicates a coagulation chemical must be injected as close as possible to an adequate amount of mixing energy. The current lack of mixing energy has been shown to result in poor coagulation, which can result in poor settling. This was a significant contributor to the plant's inability to treat highly turbid water as the applied turbidity was much higher than expected and the filters were unable to remove it. **The water plant must obtain a permit to construct piping necessary to inject the coagulant into the properly designed mixing system and maintain the mixing equipment to be in working condition at all times.**

2. The ability to see trends and react quickly is a benefit of modern technology. The water plant's computer-based data acquisition system has limited capability of easily displaying filter profiles. Most of the controllers for the online turbidimeters are outdated and have no operator interface. It also has no historian component, which would make analysis and export of data much easier. **The water system must upgrade the data management system to allow easy display and access of data, particularly turbidities.**

3. The water plant is designed with the flexibility to run the filters "to waste". This is advantageous as it doesn't stop the filtration process but eliminates the need to run filters into the clearwell and into the distribution system at all times. Currently the filter to waste system is not operable, representing another lost opportunity to operate the plant dynamically during periods of poor source water quality. **The filter-to-waste system must be repaired, and routinely used to ensure it is working**.

4. Changes in raw water quality are not uncommon, and certain practices must be in place to ensure staff and equipment are ready for the challenge. The most fundamental treatment change, that is available, is the dosing of the coagulant. It is evident in the monthly reporting for February, the water plant operators were not sufficiently trained to match the coagulant dose to changing water quality. **The water plant must develop a coagulation model, or a system for determining coagulant feed levels.** This may involve additional monitoring equipment, formalization of past practices, and laboratory activities such as jar testing to demonstrate proper coagulation.

5. Another tool at the disposal of the water operators is to slow the flow rate. The water plant has the capability to run at a slower rate by utilizing the variable frequency drives (VFDs) on the low service raw water pumps. The operators have not yet received training on slowing these pumps, which is a lost opportunity to react to changes in raw water quality. **The operators must become familiar with this equipment, and periodically operate the VFDs to ensure they are working.**

6. Two of the five high service pumps sending water to the distribution system are inoperable. The three working pumps have higher flow capacity than the two non-working pumps. This results in less contact time between the disinfectant and water in the plant's treated water reservoir. An increase in contact time results in an increase in the probability of the destruction of pathogens. Also, this situation makes it more difficult to match the pumping rates with the treatment rates. **The water system should either repair the small pumps to retain the ability to more gradually pump water or install VFDs on the large working pumps.**

Please submit a timeline for compliance with the above five items by April 15, 2018. This matter is of significant importance to the continued protection of public health, which is accomplished by operating and maintaining a resilient water treatment facility that is capable of handling changes in raw water quality.

We welcome a meeting to discuss this letter and the water supply for the City of Benton Harbor. Please contact me below to set up a meeting.

Sincerely,

Ernest Sarkipato, P.E., Surface Water Engineer
Grand Rapids District Office
Drinking Water and Municipal Assistance Division
(616)-307-0261

ES:kw

cc: Mr. Mike O'Malley, Water Plant Superintendent
Mr. Jon Bloemker, P.E., PhD, DEQ (via e-mail)

APPENDIX C

C*T Calculations

BENTON HARBOR WATER TREATMENT PLANT
C*T DETERMINATION
2018 Sanitary Survey

Basis of Assumptions

Worst case conditions were assumed to establish a conservative C*T estimate so that compliance with C*T standards would be assured under all other plant operating conditions. Those specific worst case parameters utilized were: minimum water temperature, maximum pH, minimum free chlorine residuals, maximum flow rates, and minimum volumes. A plant flow of 12 MGD was used, though this is far beyond the routine pumpage at the plant.

2018 updates: removed filter credits due to number of variables and per EPA written guidance, verified baffling factors (settling basins lowered to 0.3, reservoirs to 0.5 based on baffle walls), verified volumes for floc/sed based on as-builts, higher pH of 8.5 based on MOR review, increased Cl2 residual at plant tap of 1.0 mg/L (based on MORs).

Source of Data

Chlorine residual and raw/tap pH data were taken from the Monthly Operation Reports (MORs). Flow rate remained at 12 MGD and a conservative cold water temperature of ½ ^{o} C was used.

Total volumes for the settling basins, filters, and the finished water reservoir were taken from the Sanitary Survey Evaluation Form and were verified on construction as-built drawings. The settling basins and filters typically operate at or near maximum water levels, so no reductions in their volumes were required. Typically, the water level in the reservoir never drops below 8 feet. However, there have been rare occasions when the water level has dropped to 6.5 feet (half full). Therefore, 6.5 feet will be used in these calculations. The volume of the pipes within the treatment process, except the intake, were not included in the C*T calculations because detention times were very small.

At the Benton Harbor Water Treatment Plant, the pretreatment systems operate in parallel and there is no option for series operation.

The following worst case specific treatment parameters were obtained as described previously:

Table 1

Parameter	Value
Lowest Expected Temperature	<0.5 ^{0}C
Highest Recorded Plant Tap pH	8.5
Lowest Intake Free Cl_2 Residual	Not Applying (do not count for C*T)
Lowest Mixing Chamber Free Cl_2 Residual	1.0 mg/L
Lowest Settled Water Free Cl_2 Residual	1.0 mg/L
Lowest Filtered Water Free Cl_2 Residual	1.0 mg/L
Lowest Reservoir Water Free Cl_2 Residual	1.0 mg/L

Note: Normal application points of chlorine is at the mixing chamber, and the high service pump discharge (after reservoir).

C*T is the product of the free chlorine residual present at the effluent of a given process and the " T_{10}" detention time. T_{10} is defined as the time at which 10 percent of the step input concentration of a conservative tracer is detectable at the effluent of a given process. No tracer studies have been completed to determine accurate T_{10} values. Until tracer studies are performed, T_{10} values must be estimated by multiplying the hydraulic detention time by a baffling factor. Conservative baffling factors were chosen based on EPA guidance materials for purposes of these calculations.

The overall surface water treatment requirement is 3-log (99.9%) removal/inactivation of *Giardia* and 4-log (99.99%) removal/inactivation of viruses. Conventional filtration treatment plants (coagulation, sedimentation, and filtration) are credited with 2.5-log removal of *Giardia* and 2-log removal of viruses. The remaining 0.5-log inactivation of *Giardia* and 2-log inactivation of viruses must be achieved by disinfection.

When free chlorine is the disinfectant, the C*T required for 0.5-log inactivation of *Giardia* becomes the limiting factor. Adequate C*T for 0.5-log *Giardia* inactivation will also provide more than 2-log inactivation of viruses.

The required C*T values for free chlorine @ 0.5 ^{0}C or lower were obtained from Table C-1 provided in U.S. EPA's "Disinfection Profiling and Benchmarking Guidance Manual" (August 1999). The required C*T values are dependent on temperature, pH, and free chlorine concentration.

The C*T calculations are summarized in the following table:

Table 2

Unit Process	Intake (1)	Floc Basins (2)	Settling Basins (2)	Filters (above media) (10/12)	Reservoir (1/2 vol.)	
Volume, V (Normal) (gallons)	208,742	336,600	269,280	*Filters*	1,000,000	
Flow, Q (MGD)	12	12	12	*Removed*	12	
Detention Time, T_H (minute) =V/Q	25.05	40.4	32.3	*From the*	120	
Baffling Factor, B. F	1.0	0.7	0.3	*2018 CT*	0.5	
Effect. Det.Time,T_{10} (minute)=B.F * T_H	25	28.3	9.7	*Analysis*	60	
pH	8.5	8.5	8.5	*Per EPA*	8.5	
Chlorine Residual, C_{eff} (mg/L)	0	1.0	1.0	*guidance*	1.0	
C*T Calculation= C_{eff}* T_{10}	0	28.3	9.7		60	
C*T Reqd. for 0.5 log Giardia Inactiva.	61	61	61		61	
Log Inactivation	0.00	0.46	0.159		0.984	1.6 log

Required: 0.5 log

Volume Calculations and Baffle Assumptions

Intake – 3,950 ft x 0.785 (3 ft) ^{2} x 7.48 gal/ft^3 = 208,742 gals
Long length compared to small diameter approaches plug flow= 1.0

Flocculation basins - 168,300 gals each (30'x50'x15')
Basins are run in parallel, and cannot be run in series.
Inlet/outlet baffles with paddle mixing = 0.7

Settling basins - 134,640 gals each (30'x40'x15')
Basins are run in parallel, and cannot be run in series.
Inlet/outlet baffles and inclined plates to prevent short circuiting = 0.3

~~Filters – 349 ft^2 x 5 ft = 1745 ft^3 x 7.48 = 13,052 x 10 filters* = 130,526 gals~~
~~Square Shape but Media is an Excellent Baffle = 1.0~~
~~*2 filter cells share a common gullet, so 2 cells must be taken out of service at a time, thus 10 are operational during a backwash.~~

Filter operations have been determined to be too complex to predictably award CT without a tracer study.

Reservoirs – 2 million gals total, half full (~ 6.5 ft deep) = 1 million gals
(100' x 100' x 6.5') x 7.48 = 486,200 gals x 2 ~ 1 MG
Separate Unbaffled Inlet & Baffled Outlet = 0.5

Conclusions

It appears that the Benton Harbor Water Treatment Plant will meet C*T requirements under the conditions. The analysis is theoretical, intended to create a worst-case scenario so that under routine conditions the water plant operators have assurance C*T is met. **Table 2 indicates that a cumulative 1.6 log inactivation of *Giardia* is provided under the assumed conditions. This exceeds the required 0.5 log inactivation of *Giardia.***

While the conditions presented in this analysis are worst-case, there may exist unique situations (such as reservoir bypass) that drastically reduce the C*T achieved. As such, the City must contact the DEQ to discuss changes in treatment that may affect the ability of the water plant to meet disinfection requirements.

It is a recommendation of this survey the City obtain tools to calculate C*T each day based on actual plant conditions. This is an excellent way to remain engaged with the disinfection requirements, and may also be used as an operational tool during unique circumstances (such as reservoir going offline).

Appendix D

Asset Management Program



WATER ASSET MANAGEMENT PLAN

December 2017

Prepared by:

ABONMARCHE

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1 Executive Summary

1.0 Introduction

The Michigan Department of Environmental Quality (MDEQ), through Michigan's Safe Drinking Water Act, has implemented the requirement that community water supplies servicing more than 1,000 people, prepare and execute an Asset Management Plan (AMP) for their water system. The City of Benton Harbor with a population of 10,038 per the 2010 census, meets the requirements for implementation of an AMP for their water infrastructure.

The goal of the AMP process is to provide the municipality with a comprehensive understanding of the quantity and condition of their existing system to ensure proper measures are being taken to provide a safe and reliable supply of water to consumers. Asset Management Plans analyze life cycle costing to develop a long term plan that associates the needed funding to projects that will be done in the future that include repairing, replacing or rehabilitating particular assets. This ensures that the water system will deliver the desired level of service perpetually.

The AMP consist of five core components as described in the MDEQ document, "Asset Management Guidance for Water Systems" these include:

- Asset Inventory
- Level of Service
- Critical Assets
- Revenue Structure
- Capital Improvement Project Plan

This Water Asset Management Plan was structured to follow the format suggested in the MDEQ "Asset Management Guidance for Water Systems."

1.1 Mission Statement

The Michigan Department of Environmental Quality requires that for an AMP to be approved there must be a mission statement. A Mission Statement is developed to represent the purpose and goals of the water department. The Mission Statement defines the asset management program. The following is a derivation of the standard mission statement recommended by the MDEQ in lieu of a formal statement by the municipality:

We commit to protecting public health, and maintaining and improving performance of our drinking water plant and distribution system assets, while minimizing the long-term cost of operating those assets. We strive to make the most cost-effective renewal and replacement investments and provide the highest-quality customer service possible.

1.2 Asset Management Team

The MDEQ also requires an Asset Management Team be established to oversee the asset management program. The team will also ensure that the mission statement is being fulfilled. When assembling an Asset Management Team, it is important to consider current and past municipal staff (officials, board members, clerks, accountants, and engineers), current and past utility staff (operators and other service workers), and any other stakeholders that can help in assembling the information to develop this Asset Management Plan. Provided below in Table 1 is a summary of the AMP Team. As the AMP is updated, these contacts may be updated and reviewed to determine if additional members are required or other changes are needed to best complete the stated goals of the AMP.

Table 1: City of Benton Harbor Water AMP Team

Member Role	*Current Member*
City Manager	Darwin Watson
Public Services Director	Michael O'Malley
Water Treatment Superintendent	Michael O'Malley
Engineer	Abonmarche

2 Asset Inventory

2.0 Introduction

The first core component of asset management, according to MDEQ, is the asset inventory. The following questions are a guideline for developing an inventory:

- What do I own?
- Where is it?
- What condition is it in?
- What is its remaining useful life?
- What is its value?

Developing the initial inventory on what assets the city owns can be one of the most difficult steps. The majority of the assets for a water system are underground and hidden from view. Therefore, it is difficult to keep track of what is there and what condition it is in. To develop the initial inventory, as-built drawings, invoices, staff knowledge, visual observation, interviews with residents and consultants are all resources that were used. Asset inventory is an ongoing process that should be updated when changes are made to the water system.

2.1 Water System Inventory

The first step in the asset management plan is to determine what assets are owned and maintained by the municipality. These assets for the water utility include not only the

physical pipes that transport water to users but also the water plant, storage facilities, pumps, and fire hydrants. A summary of owned water facilities can be seen in Table 2.

Table 2: Summary of Water Assets

Asset	*Measure*
Water Plant	Renovated 2010-2011
Water Distribution (Pipes)	347,645 Feet (65.8 miles)
Water Meters	2,844
Fire Hydrants	509
Water Tower	1 @ 650,000 Gallon Capacity

Maintenance of these assets is critical to meeting the city's goal of providing safe and reliable drinking water to its users. To complete an accurate and useful asset management plan it is important to gather as much data on the existing age and condition of all assets related to a utility. A more detailed summary of the above listed assets is provided in the following sections.

2.1.1 Water Plant

The Benton Harbor Water Plant is located at 601 Ridgeway, St. Joseph, MI, in the southwest corner of Jean Klock Park near the Lake Michigan shoreline. Built around 1955 by Pearson Construction Co., it is rated by the Michigan Department of Environmental Quality (MDEQ) as an F-1 Complete Treatment Surface Water Treatment Plant and is regulated by the Michigan Safe Drinking Water Act 399 in accordance with the Surface Water Treatment Rules (SWTR). From 2010-2011, the water plant was refurbished and expanded using Michigan's Drinking Water Revolving Loan Funds (DWRLF). Operation was restored to 16 million gallons of water per day (MGD) and technology improvements included: chemical treatment, safer and easier disinfection, particulate matter removal, waste treatment, and other operational equipment.

The current process of the water plant starts with raw Lake Michigan water conveyed via one or more of five low lift pumps at a typical rate of 2-5 MGD from an intake structure located 5,000 feet from the plant in Lake Michigan though a 30-inch diameter pipe to a raw water lift station and wet well. Liquid sodium hypochlorite, in 15% solution, is added as a disinfectant. Liquid aluminum sulfate, in 48% solution, is added to facilitate the chemical binding and settling process of coagulation. Hydrofluorosilicic acid (HFSA) is also added but will soon be switched to a granular sodium fluoride. The pumped raw water that has been chemically treated is discharged into the mixing portion of the two plate settler basins where the flow is mixed in five stages: in the pipeline, in the rapid mixer, and in three successively slower flocculation mixers. During this mixing, the alum destabilizes the particles and then acts as a binding chemical that forms a piece of insoluble floc. The water then enters a plate settler chamber where the floc is settled to the bottom and clear water is drawn off the upper levels. More than 95% of the suspended solids are removed in the flocculation/settling process. The water then flows

to the filters where additional suspended solids are removed before flowing to two underground reservoirs.

2.1.2 Distribution Piping

The existing water distribution system includes over 65 miles of 2" through 20" water main. The mains adjacent to the water treatment plant are 20" and main transmission lines are 8-20" in size. Many residential areas are served by 4"-8" mains. A significant portion of the city (23.7%) is served by mains 2" and 4" in diameter, inadequate for distribution systems with fire protection. Water is pumped from the reservoirs at the water plant via one or two of five high lift (HS) pumps at a rate of either 2 MGD or 4 MGD to the system at 70 to 90 psi. One 2 MGD pump is used during normal consumption to maintain a safe level in the Britain Avenue water tower. A second pump, with a capacity of 4 MGD, is used during emergency situations when the safe level is not maintained. Two 20-inch pipes carry the water from the plant to the city; 12-16-inch pipes distribute the water and 4, 6, & 8-inch pipes deliver water to homes and small businesses.

Improper and lack of looping water mains also causes reduced pressures, stagnant water and increased maintenance. The system is generally well looped, except at the now unused connection with Benton Charter Township on Pipestone and at the City borders. Improper sizing can also be detrimental to the overall pressure in the system, much of the residential areas are fed with 4" main which are too small to generate suitable fire flows.

The system was designed to distribute water to a much larger area than it currently supplies: Benton Charter Township now receives water from the Benton Charter Township Water Plant, St. Joseph Township now receives water from the St. Joseph Water Plant. The City of Benton Harbor distribution system still consists of the large mains that were necessary to distribute water to those further areas, but now only distributes water within the City limits. Therefore, large mains are feeding 4" mains in neighborhoods.

The current 10 State Standards for Water Works recommend water main diameters six (6) inches or greater with most typical applications calling for an eight (8) inch water main as a minimum diameter in order to provide adequate fire protection while maintaining acceptable residual pressures in the system. A breakdown of the City's water distribution system by pipe diameter can be seen in Table 3 and Figure 1. This breakdown shows 83,081 feet of the city's water distribution piping, 23.9% of the system, falls below the 6 inch minimum standard with a further 116,839 feet, or 33.6%, right at the 6 inch minimum diameter.

Table 3: Water Distribution Network Summary

Pipe Diameter (Inches)	Length of Pipe (Feet)	% of System
2	771	0.2%
4	82,310	23.7%
6	116,839	33.6%
8	44,398	12.8%
10	6,964	2.0%
12	57,054	16.4%
16	10,135	2.9%
18	1,181	0.3%
20	27,993	8.1%
Total	**347,645**	**100%**

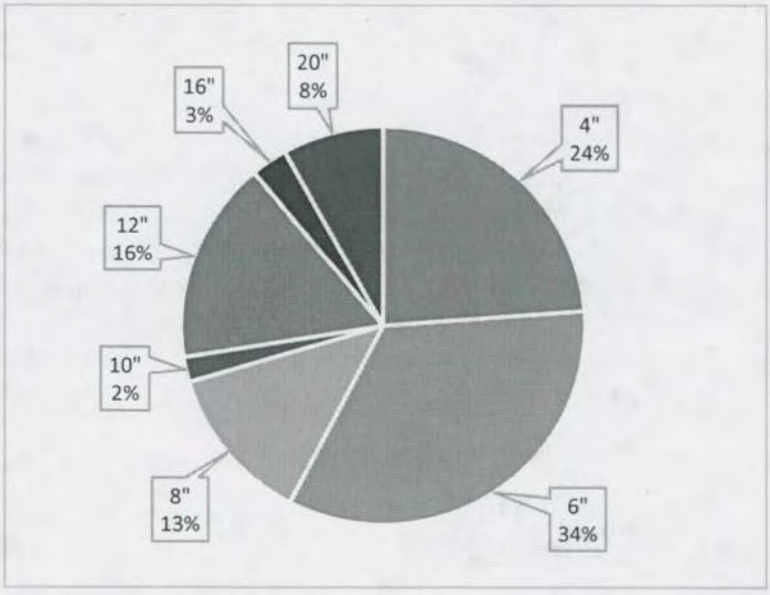


Figure 1: Water Distribution Network Summary (By Size)

A further breakdown of the existing distribution network, showing both piping materials and sizes is presented in Figure 2. An overall listing of all mains owned by the city can be found in Appendix A following this report.

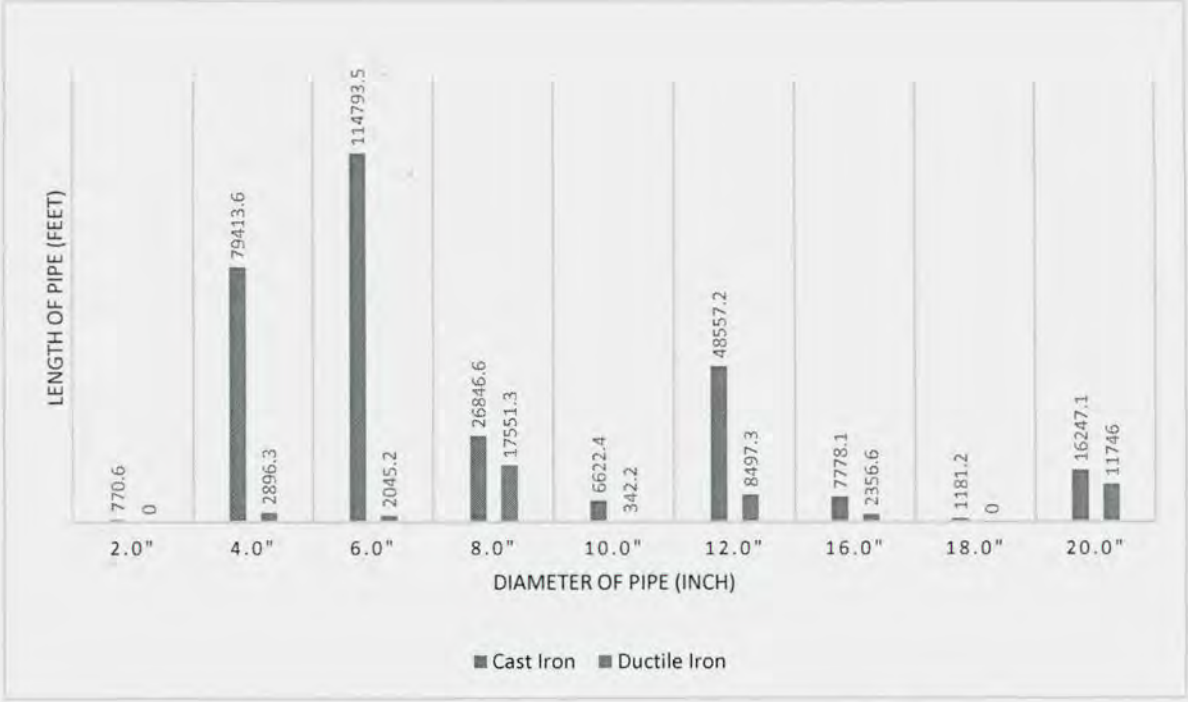


Figure 2: Network Pipe Material and Size Distribution

Table 4 and Figure 3 show the age ranges within the system. 75% of the system is greater than 50 years of age. Underground pipes have an effective life based on the pipe material and installation practices used during their installation. Galvanized pipes generally have an estimated effective life less than 50 years while cast iron pipes can last 75 years, and new ductile iron or plastic pipe materials are capable of lasting 90 years or longer with modern construction practices. The advanced age of the water distribution network is a significant factor in the condition assessment and probability of failure discussed later in the report.

Table 4: Water Distribution Network Summary (By Age)

Age Range	Length of Pipe, feet	%
0 - 25	49,440	14.2%
26 - 50	36,664	10.5%
51 +	261,541	75.2%
Total	**347,645**	**100%**

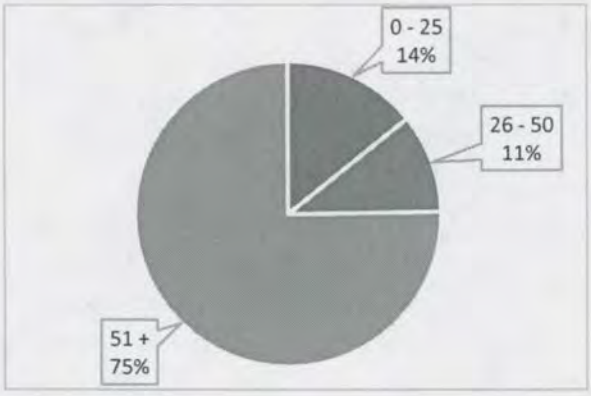


Figure 3: Water Distribution Network Summary (By Age)

2.1.3 Water Meters

The city currently utilizes 3,476 total service connections, 2,844 of these are metered. 2,612 of the meters were recently replaced as part of the SAW grant to provide more accurate readings. Water service connections that are not metered include; City Hall, the police station, the fire station, and several parks, with more being discovered. Water meters measure water usage for residential, commercial, industrial, and governmental customers. The current estimated breakdown of meter usage can be seen below in Table 5.

Table 5: Summary of Existing Water Meters by Use

User Type	Number of Meters	% of System
Residential	2,474	87%
Commercial	199	7%
Industrial	114	4%
Mixed Use	57	2%
Total	**2,844**	**100%**

2.1.4 Fire Hydrants

509 fire hydrants are connected to many strategically placed points on the system. The placement varies based upon the number and types of structures that may catch fire and the availability of water in the water mains around these structures. The ISO Criteria generally requires a flow of 1,000 to 1,500 gpm in residential areas (1- and 2- family dwellings not exceeding two stories in height) and up to 2,500 gpm in commercial areas. The minimum residual pressure at the fire flow is commonly required, by the National Board of Fire Insurance Underwriters, to be 20 psi. A detailed summary of improvements recommended based on increasing fire flows can be found in the reliability study recently completed. A map showing the location and classification of the hydrants as of 2017 can be found in Appendix B. 4" and 2" pipes throughout the City should be generally replaced with 8" to improve fire flows throughout the City. A minimum of 8" Ductile Iron

should be the standard used in any water system replacements or improvements throughout the City. We suggest further investigation via a hydrant flow testing program to best determine where localized hydrant and valve issues are present. A valve turning program is also recommended to better understand the system and improve faults.

2.1.5 Water Tower

A single pedestal elevated storage tank provides the City with water storage for fire protection and to improve system pressure. The water tower is located at Britain and 8th Street. The elevated tank was constructed in 1962 by Pittsburg Steel Company and has a storage capacity of 650,000 gallons. The elevation of the water tower provides 70-75 psi of pressure for the nearby water system. The water tower was last painted in 1990 and the last full inspection was performed by Dixon Engineering in 2008. A copy of this report can be found in Appendix C. In 2013, a partial inspection was performed by Dixon to look for damages relating to an overflow event.

2.1.6 Drinking Water Source

The drinking water source for the City of Benton Harbor is Lake Michigan. 5,000 feet of 36" piping that extends into the lake to an intake structure. In regards to the drinking water source quality, the City of Benton Harbor performs yearly water quality analysis and reporting to inform the public about drinking water quality. Water Quality Reports are created annually and made available to the public via the city's website. Water Quality Reports from 2011, 2012, 2014, 2015, and 2016 can be found in Appendix D.

2.2 Condition Assessment, Remaining Life and Value

Once an inventory of assets to be included in the asset management plan has been collected and reviewed, the next step is determining what the current condition of these assets are, how much remaining life they have, and what their overall value is. Determining the condition of the asset can help estimate what its remaining life will be. Knowing this information will help the city in setting budgeting priorities in the short and long term. Assets are hidden underground so it is difficult to determine their current condition through physical examination. Therefore, record documents are often the easiest way to estimate age.

To determine the anticipated condition of the water system in the City of Benton Harbor, historical mapping and as-built drawings from previous projects were collected and reviewed. As records for the water system have not been consistently updated, we had to make assumptions of the current approximate age of the pipe network. Any pipes installed prior to 1970 were assumed to be cast iron unless otherwise noted and pipes less than thee (3) inches in diameter were assumed to be galvanized unless otherwise noted. Appendix A provides a complete listing of the distribution network in the city which shows the assumed age, size, and length of distribution piping along with other related information.

In regards to anticipated life of the distribution network, Table 6 shows the service life values that were assumed for a given material.

Table 6: Distribution Pipe Service Life Summary

Material	*Service Life (Years)*
Galvanized	40
Cast Iron	75
PVC	90
Ductile Iron	90

It is important to have an order of magnitude understanding of the present value of assets owned so that maintenance and rehabilitation costs can be justified. In plain terms, more overall assets means more money needs to be allocated to their maintenance. Table 7 below summarizes and approximate value of the water distribution asset (water main, hydrants and valves) in the City.

Table 7: Water Distribution Replacement Values

Pipe Diameter (Inches)	*Length of Pipe (Feet)*	*Unit Replacement Cost ($/Foot)*	*Current Replacement Value ($)*
2.0*	771	$320	$246,720
4.0*	82,310	$320	$26,339,200
6.0*	116,839	$320	$37,388,480
8.0	44,398	$335	$14,873,330
10.0	6,964	$395	$2,750,780
12.0	57,054	$405	$23,106,870
16.0	10,135	$450	$4,560,750
18.0	1,181	$485	$572,785
20.0	27,993	$525	$14,696,325
Total	**347,645**		**$124,535,240**

*Assumed that mains 6 inches and under would be sized to the new 8 inch standard
** - Unit costs include removal and replacement of water main, installation of control valves, hydrants, and water services as well as replacement of pavement/surface improvements associated with a 10 foot wide trench.

3 Level of Service

3.0 Introduction

As described in the MDEQ Guidance Document, Level of Service (LOS) defines the way in which the utility stakeholders want the utility to perform over the long term. The LOS can include any technical, managerial, or financial components the utility wishes, as long as all regulatory requirements are met. The LOS will become a fundamental part of how the utility is operated.

All utilities must operate within the state and federal regulations and requirements. These regulations are generally specified in the Safe Drinking Water Act for water systems but there are additional rules and regulations at the state and federal level. Although the state and federal regulations set bare minimum standards of operation in the LOS, these standards will not adequately address all areas of operation and should not be the sole factor of the LOS. Utilities should include many other factors to delineate important areas of the utility's operation.

Within the range of the minimum (regulations) and maximum (absolute capabilities of assets), there are numerous items a utility could include within its LOS. Items may be included so the utility can communicate its intentions with its customers, measure its performance, and determine critical assets. Understanding what LOS to choose will help in developing an Asset Management Plan that truly captures the utility's performance and how to accomplish future goals.

Defining the LOS sets the goals for the utility. These goals allow the operations staff to have a better understanding of what is desired from them, and give management a better understanding of how to use staff and other resources more efficiently and effectively. Reviewing how the utility is meeting LOS also allows the management to shift resources if needed from one task to another to meet all the goals most effectively. Understanding the desired LOS will help to prioritize and characterize the system's assets, as well as how to manage finances to reach the LOS goals.

There is a direct link between the LOS provided and the cost to the customer. When a higher LOS is provided, costs to provide that level will likely increase. This direct link demands that the utility have an open dialogue with its customers regarding the LOS desired and the amount the customers are willing to pay for this LOS or increased services.

Typical questions to consider when developing the LOS for the system:

1) What is the LOS goal for health, safety, and security?

2) How often is the system out of compliance with regulations?

3) Are the operators properly certified?

4) How does the utility stay aware of and prepare for new regulations?

5) Do you share your LOS statement with your customers?

6) How do you track and respond to customer needs/complaints?

7) Can the current process be improved?

8) How quickly does the utility respond to customer issues?

9) Is maintenance being deferred to save money?

10) How much will the improvements cost and how will they be funded?

11) Are assets being properly maintained to insure they are in reliable working condition?

12) What areas within the system are most important to insure the best LOS possible?

13) When considering a preferred LOS, are asset age and life cycles, asset conditions, funding availability, etc. being factored in?

14) How often will the LOS statement be reviewed in order to capture changes such as funding availability (growth and decline), regulatory requirements, demand of customers (increases/decreases in customers), and physical deterioration of assets (addressing maintenance)?

15) Are O&M activities being maximized to meet the LOS goals?

3.1 Level of Service Goals

Upon review with the City, the following general LOS goals were selected as a guide to managing their water system.

- Deliver safe drinking water to all users
  - Meet State and Federal requirements for contaminants
- Ensure that taste and appearance are acceptable to all users
  - Meet selected secondary standards for taste, clarity, and color
  - City can track user feedback on water quality issues through City Works
  - Compliance tracked with laboratory testing and Monthly Operating Reports
- Provide adequate fire flows to ensure safety of community
  - "AA" (>1,500 gpm) flows to all commercial, industrial, and educational uses
  - "A" (>1,000 gpm) flows to all residential areas with City limits
  - Track with annual hydrant testing and 5-year computer modeling
- Undertake all necessary preventative maintenance and corrective actions on the system
  - Ensure that assets are meeting or exceeding their lifespans in good condition
  - Minimize cost of ownership
  - Minimize user interruptions due to unscheduled repairs and breaks
  - Record water line breaks so that trends can be identified and priorities can be adjusted

4 Asset Criticality

4.0 Introduction

The criticality of an asset is related to its probability of failure and its consequence of failure. Assets will have different criticality ratings. Criticality ratings are important in determining what assets need attention first. Assets with a higher criticality rating should receive priority first and should be outlined in the city's Asset Management Plan as being

a future project. This allows the city to start budgeting for the work that needs to be done. The two components of assessing criticality, Probability of Failure and Consequence of Failure, are described below.

4.1 Probability of Failure (POF)

Probability of Failure is estimating the likelihood that an asset will fail in the future. A ranking system to compare the probability of failure of multiple assets must be developed first before assigning a rating to each asset. By using the service life values defined in Table 6, and taking the assumed age of the pipes in the distribution network we are able to determine the anticipated probability of failure using equation (1) below. The result of this ratio is multiplied by 10 for use in criticality analysis of the network which is discussed in detail further in the report. In regards to probability of failure, a newly installed pipe will have a POF value of 0 which indicates very low to no probability of failure. A POF value of 10 indicates that the asset has reached or exceeded its intended service life and failure is likely imminent or that the reliability of the asset is severely degraded.

Equation (1): $$Probability\ of\ Failure\ (POF) = \frac{Age\ of\ Asset\ (Years)}{Service\ Life\ (Years)} * 10$$

If Age of Asset > Service Life, POF = 10

Figure 4 below shows a breakdown of the distribution network based on the POF rankings. Much of the system has aged to or beyond its maximum life as indicated by the large amount of the network in the 9-10 rating category. However, recent improvements to the water network have been completed, which is seen by the fair amount of pipes in the 0-2 rating category.



Figure 4: Network Probability of Failure Distribution

4.2 Consequence of Failure (COF)

Consequence of Failure is estimating all of the potential costs that will occur when there is failure to the asset. There are multiple costs to consider and often it tends to be a chain effect and accumulation of multiple different costs. Examples of the potential costs include: cost of repair; social cost associated with the loss of the asset; repair/replacement costs related to collateral damage caused by the failure; legal costs related to additional damage caused by the failure; environmental costs created by the failure; loss of business revenue to the community and any other associated costs or asset losses.

Table 8 below outlines the Consequence of Failure Levels that were developed and applied for this Asset Management Plan. It provides a summary of the selected factors and the ranges that were used to weight a given factor. As certain parameters, such a pipe size, play a larger role in determining consequence these factors were given greater overall weight in the scoring process.

Table 8: Consequence of Failure Levels

Factor & Weight	*Range of Value*	*Multiplier*
Size of Pipe (Inches) W: 5	< 4	0.1
	4 - 6	0.4
	8 - 10	0.7
	≥ 12	1.0
Proximity to Buildings W: 2	X ≥ 10	0
	5 < X < 10	0.5
	≤ 5	0.8
	0	1.0
Proximity to Roadways W: 3	Outside ROW	0
	In ROW Alley/Minor Road (Not Under)	0.2
	IN ROW Major Road (Not Under)	0.5
	Under Alley/Minor Road	0.8
	Under Major Road	1.0

The formula for determining COF has a value range of 0.5 to 10 with a lower score indicating the lowest criticality (small pipe, far away from buildings, outside of the ROW) and a 10 indicating the most critical situation (large pipe, under a building, under a major roadway). Equation 2 presented below was used in the calculation of criticality as previously discussed.

Equation (2): $Consequence\ of\ Failure\ (COF) = S * 5 + Prox_B * 2 + Prox_R * 3$

Where:
S = Size of Pipe
$Prox_B$ = Proximity to Buildings
$Prox_R$ = Proximity to Roadways

Figure 5 below shows a breakdown of the distribution network based on the COF rankings.

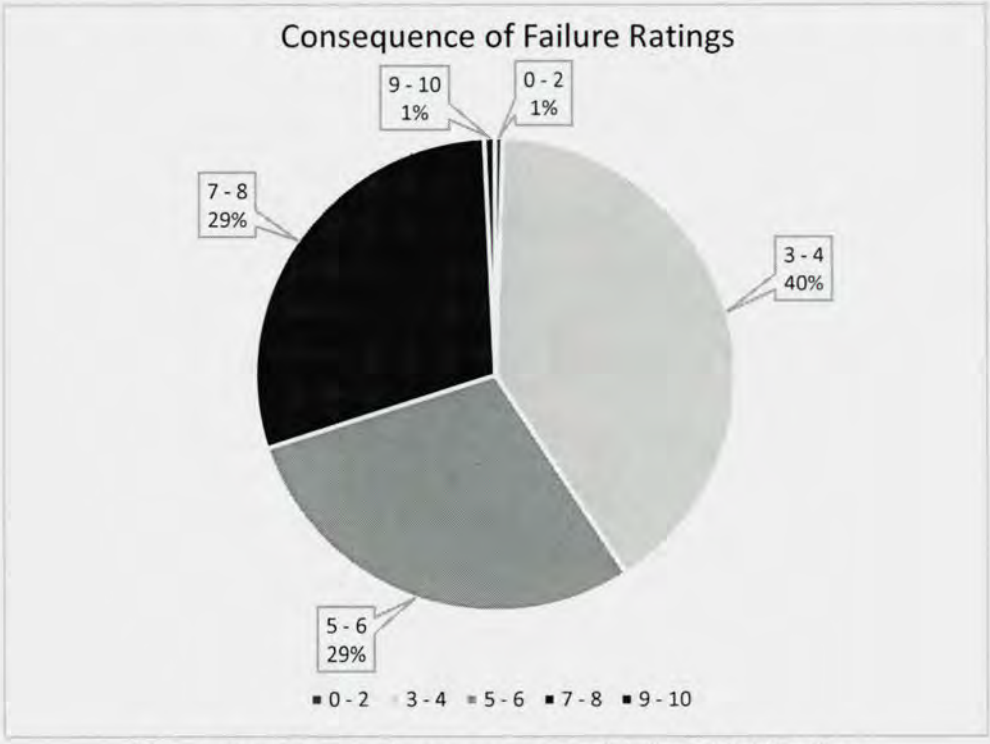


Figure 5: Network Consequence of Failure Distribution

4.3 Criticality & Business Risk Evaluation

Multiplying the Probability of Failure (POF) and the Consequence of Failure (COF) together results in determining the criticality, also referred to as the Business Risk Evaluation (BRE). The assets that have the greatest probability of failure along with the greatest consequence of failure will be the most critical. The equation for calculating the BRE can be seen below.

Equation (3): $BRE = POF * COF$

Where:
BRE = Business Risk Evaluation
POF = Probability of Failure
COF = Consequence of Failure

The product of multiplying the probability of failure with the consequence of failure produces a BRE score of 1 to 100. A BRE score of 1-20 is considered low priority, 21-55 are medium priority, and 56-100 are high priority. Table 9 shows the criticality matrix used for analyzing the assets. Assets with the highest BRE scores should be considered candidates for the 5-year or 20-year Capital Improvement Project list. Appendix A shows all the BRE scores for the Benton Harbor Water System. Appendix E provides mapping based on a variety of factors including remaining useful life, probability of failure, consequence of failure and criticality.

Table 9: Business Risk Evaluation Score Priority Matrix

Consequence of Failure (COF)											
	10	10	20	30	40	50	60	70	80	90	100
	9	9	18	27	36	45	54	63	72	81	90
	8	8	16	24	32	40	48	56	64	72	80
	7	7	14	21	28	35	42	49	56	63	70
	6	6	12	18	24	30	36	42	48	54	60
	5	5	10	15	20	25	30	35	40	45	50
	4	4	8	12	16	20	24	28	32	36	40
	3	3	6	9	12	15	18	21	24	27	30
	2	2	4	6	8	10	12	14	16	18	20
	1	1	2	3	4	5	6	7	8	9	10
		1	2	3	4	5	6	7	8	9	10
	Probability of Failure (POF)										

Figure 6 breaks down the current system by BRE ranking (low, medium, or high). More than 85% of the system is in a medium or high risk category from a BRE perspective. Projects will be selected from the 17% of the network that is currently in the high risk category.

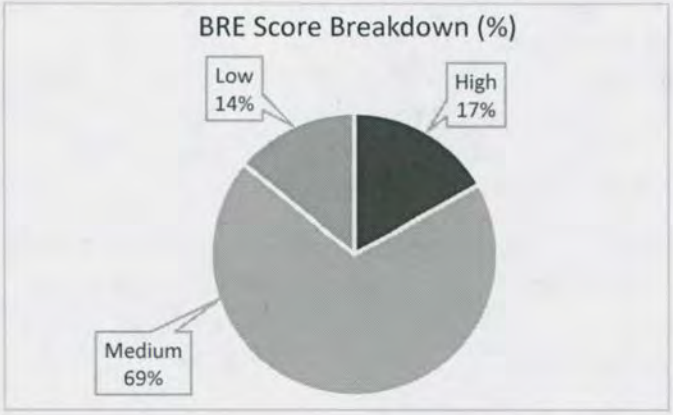


Figure 6: Network BRE Score Distribution

5 Revenue Structure

5.0 Introduction

To help fund rehabilitation or replacement of assets, methodologies are used to determine how revenue is generated. First, the fixed rate methodology can be utilized. Fixed rate methodology is a tool used to determine rates and charges to provide sufficient revenues to cover generally fixed costs that usually occur like the operation, maintenance, and replacement of assets. Next is billable flow methodology which generates revenue through a commodity rate based on consumer usage to address variable costs based upon flow, such as utility consumption. A fixed and variable methodology is typically used. In this method, revenue is generated from two sources, the fixed unit for the source and a commodity rate.

Once total expenses have been determined, the rates and charges for the user can be reviewed to ensure that there is sufficient revenue to cover expenses. If a shortfall exists, then the users are not paying for the cost of service and the difference must be addressed. Occasionally, temporary subsidies are necessary to cover unexpected expenses. However, a continuous use of subsidies will result in rate increases in the future or a deficit in the budget.

The City of Benton Harbor owns and operates the Drinking Water System and has the authority to establish rates to be charged for services as needed.

5.1 Operation & Maintenance Budget and Staff Structure

The annual operation and maintenance (O&M) budget includes typical costs associated with operating and maintaining the system for a year. Excluded from this budget are any major capital improvements that are needed to increase capacity or replace items with a useful life of more than 20 years. Included in the budget are the costs associated with personnel, energy use, supplies, etc. Budgetary projections assume an annual 3% increase in expenses to account for inflation and other factors.

The budget needs to account for the inflation of cost, wages, and utility charges. Efficiency within the City water distribution system is dependent on an adequate and qualified staffing structure. Table 10 is an outline of the existing city staffing that contributes to maintaining the water distribution system. That is, all employees from the department of public services including those who work specifically for the water department. The City will be facing the retirement of several key personnel within the 20 year planning period. Therefore, after the initial 5-year planning horizon, operating expenses are expected to remain flat.

In 2011, the emergency City manager set up a schedule for rates to increase to cover the cost of inflation, operations, maintenance and replacements to the system, and debt service cost on bonds. In 2013, a different emergency City manager approved a 5% reduction in this rate to reduce the financial burden placed on the residents who were facing economic hardships as the City was in a fiscal position to reduce the rates. The city currently operates with a water department budget of $2 million which provides

funding sufficient to address operations but may fall short of the funds needed to cover current debt payments. It appears that a 15% rate increase may be necessary in the next 6 months to close the funding gap for current debt. Annual increases of 2.5% -6.5% will also be needed until 2022. A larger rate increase, grant, or other mechanism of funding will be required to pay off debt necessary to complete all of the projects outlined in this report in 2023. More detail on this is included in Appendix G.

Table 10: City of Benton Harbor Public Services Department Staff Structure

Name	Title	DOB	DOH	License(s)
Michael O'Malley	Superintendent of Water Plant	9/27/1957	7/18/2016	S1 / F1 Certificate
Denny Edwards	Utility Service Operator I	10/20/1967	9/13/1994	F4 / S4 Certificate
Douglas Vanderploeg	Utility Service Operator I	5/20/1956	2/27/1992	F3 / S3 Certificate
Henry Clayton	General Labor	7/24/1978	9/15/2014	N/A
Eddie Davis	Heavy Equipment Operator	6/17/1973	10/20/2003	CDL Certificate
Shawn Echols	General Labor	7/4/1969	3/20/2017	N/A
Steve Forbear	Mechanic	11/17/1965	5/11/2015	CDL Certificate
Micah Goss	General Labor	2/18/1997	1/19/2016	N/A
Dennis Hudson	Heavy Equipment Operator	7/15/1965	11/25/2002	CDL Certificate
Floyd Johnson	Utility Service Technician I	10/1/1981	7/7/2016	CDL Certificate
Dimetrius Meeks	Supervisor Dept. of Public Works	8/15/1972	5/13/1997	N/A
Patrick Patterson	Heavy Equipment Operator	8/30/1963	5/2/2015	CDL Certificate
Richard Woods	Utility Service Technician I	8/20/1960	5/29/2013	CDL Certificate
Thomas Woodson	General Labor	9/19/1954	11/24/2014	CDL Certificate
Eddie Ellis	Utility Service Technician II	9/4/1969	11/30/2001	N/A

5.2 Replacement Fund

The rate methodology should include a replacement schedule for short-lived assets. The breakdown will identify items owned by the utility that have a useful life of 20 years or less

and contain moving parts. The replacement items will appear in the asset inventory, but should have a dedicated funding source due to their limited useful life and importance. On an annual basis, replacement funds are set aside and saved until needed. Once a particular item fails, money is drawn from the replacement fund to replace the failed item without having to disrupt the normal operating budget.

Most of the time, it is not known when any asset will need to be repaired or replaced, but their end of life has been estimated in this plan. The amount should be set aside each year, so that when a repair is needed, the funds are available without having to borrow money for the expense. The replacement schedule can be reviewed and amended annually for budgeting purposes.

6 Capital Improvement Project Plan

6.0 Introduction

A long-term Capital Improvement Plan (CIP) should look at the utility's needs for the future. Ideally, the planning period would be at least 20 years, with a 5 year plan identifying more pressing needs. It should be understood that the specific expenditures and needs of the utility in the latter years, 15 to 20 years, are more speculative than the needs for the first 5 to 10 years, particularly the first 5 years. However, the inclusion of the needs for this longer time period will provide a better opportunity for the water system to plan for its capital needs. Capital improvement projects are projects that the utility has an extended period of time to plan for and are projects that usually cover high cost, non-recurring items.

After the city has determined the projects it will include in its Capital Improvement Project Plan the next step is to associate an estimated cost to these projects. Once an estimated cost is developed, then is it important to think about how the project will be funded in the future. The city should plan on funding the majority of the capital improvement projects from its Water System revenue. Additionally, the city may look for outside sources of funding for projects. Grants and low interest loans should be explored to reduce the impact on rate payers. The city must budget and adjust their rates annually to address operational and capital improvement costs.

6.1 Water System Reliability Study

In 2017, Abonmarche completed another report related to the water distribution system in Benton Harbor. This was a Water System Reliability Study that focused on computer modeling the pressure in the system with reference to the desired fire flows in certain areas. The recommended project upgrade areas can be found in Tables 14 & 18. The full report can be found under the cover, "Water System Reliability Study."

6.2 Recommended CIP Projects

6.2.1 Five (5) Year CIP Plan

Presented on the following pages are the five (5) year projects for the water supply, storage, and distribution systems. To complete all the listed projects an estimated $15,798,790 would be required, which works out to approximately $750,000 per year

assuming a 30-year low interest loan is utilized for funding. Appendix F provides a detailed breakdown of the estimated costs for performing the water distribution 5 year CIP Plan.

Table 11: Water Supply 5 Year CIP (2020)

#	Project Description	
1	Backwash & Waste Lagoon Improvements	
2	High Service Pump #5 Soft Starter	
3	New High Service Pump with VFD	
4	Repair Roof over Offices	
5	Software for Operations Computer	
6	Zebra Mussel Pretreatment & Control	
7	Alum Treatment	
8	Overflow Protection	
9	SCADA System Improvements	
10	Pump Overhauls	
5 Year Water Supply CIP Estimate		**$1,000,000**

Table 12: Water Storage 5 Year CIP (2018-2019)

#	Project Description	Estimated Cost
1	Exterior High Pressure Water Jet & Acrylic Recoat (Year 1)	$195,000
2	Cathodic Protection System Repair	$3,800
3	Adjust Sway Rods	$3,000
4	Install 30" Diameter Manway in Riser	$7,000
5	Install 30" Roof Hatch	$3,000
6	Install Roof Railing with Painter's Rail	$12,000
7	Paint Pit Piping	$5,000
8	Install Wet Interior Ladder with Fall Prevention	$8,000
9	Replace Sidewall Ladder with Vertical Ladder	$10,000
10	Weld Cathodic Caps and Hole in Roof Vent	$3,000
11	Repair & Replace Roof Beams and Plug Holes	$20,000
12	Repaint Interior	$50,000
5 Year Water Storage CIP Estimate		**$319,800**

Table 13: Water Distribution 5 Year CIP from Criticality Ratings (2023)

#	Location Description	Estimated Construction Cost
1	Britain Avenue (Riverview to Pipestone)	$3,022,890
2	8th Street (Hinkley to Britain)	$1,770,471
3	Pipestone Rd (Main Street to Washington Street)	$719,352
4	Michigan St. / E. Wall St / Highland Ave (Pipestone St to Jefferson)	$753,810
5	Whitwam-Riverview Dr (Main Street to Whitwam Dr)	$292,512
5 Year Water Distribution CIP from Criticality Estimate		**$6,559,035**

Table 14: Water Distribution 5 Year CIP from Reliability Study (2023)

#	Location Description	Estimated Construction Cost
1	Stevens (Riverside to Waukonda) Riverside (McCord to Stevens) Buena Vista (Winans to Waukonda) Winans (Buena Vista to Waukonda)	$1,604,025
2	Edwards (Winans to Morton)	$664,950
3	Morton (Green to Territorial) Green (Winans to Morton)	$740,100
4	Washington (Ross to Pipestone) Vineyard (East End to Ross)	$922,650
5	Britain Avenue (Seeley to McCord) Seeley (Britain to Pitkins) Pitkins (Fair to Warwick) Warwick (Fair to Pitkins)	$1,885,845
6	Robbins (Colfax to Windsor) Windsor (Colfax to Robbins) Salem (May to Robbins)	$1,571,685
7	Monroe (Cross to Emery)	$530,700
5 Year Water Distribution CIP from Reliability Study Estimate		**$7,919,955**

6.2.2 Twenty (20) Year CIP Plan

Presented on the following pages are the twenty (20) year projects for the water supply, storage, and distribution system. To complete all the listed projects an estimated $35,472,668 would be required, which works out to approximately $1.7 million per year if completed all at once with a 30-year low interest loan (assuming today's dollars for construction cost estimates). Appendix F provides a detailed breakdown of the estimated costs for performing the water distribution 20 year CIP Plan.

Table 15: Water Supply 20 Year CIP (2033)

#	Project Description
1	Repair Filters
2	Pump Replacement
3	Other Miscellaneous Needs
4	SCADA System Improvements
5	Pump Overhauls
20 Year Water Supply CIP Estimate	**$500,000**

Table 16: Water Storage 20 Year CIP (2033)

#	Project Description	Estimated Cost
1	Replacement of Water Tower	$3,000,000
20 Year Water Storage CIP Estimate		**$3,000,000**

Table 17: Water Distribution 20 Year CIP from Criticality Ratings (2033-2037)

#	Location Description	Estimated Construction Cost
1	Empire Ave (Riverview Dr to Salem Ave)	$736,058
2	Empire Ave (Columbus Ave to Ogden Ave)	$191,026
3	Empire Ave (Jennings Ave to Pipestone St)	$303,267
4	Salem Ave (Empire Ave to May St to Colfax Ave)	$601,043
5	Emery Ave (Union St to Milton and Hurd Ave south)	$519,476
6	Pearl St (Catalpa Ave to Empire Ave)	$641,992
7	Catalpa Ave (Colfax Ave to Columbus Ave)	$674,258
8	Pavone St (Lake Ave to Catalpa Ave)	$582,583
9	Ohio St Alleys (Britain Ave to Pavone St)	$313,131

10	Lake Ave (Market St to Broadway Ave)	$705,184
11	Broadway Ave / Jefferson St (Lake Ave to Highland Ave)	$720,545
12	McCord St (Main St to Britain Ave)	$1,320,774
13	2nd St (Klock Rd to Highland Ave)	$1,596,099
14	Waukonda Ave (Nowlen St to Fair Ave)	$712,673
15	Bond St (Market St to Colfax Ave)	$793,524
16	9th St (Main St to Oak St)	$293,589
17	Territorial Rd (4th St to 2nd St)	$285,734
18	3rd St / East Alley (Territorial to Highland Ave)	$418,060
19	8th St (Klock Rd to Graham Ave)	$955,494
20	Wall St (Riverview Dr to 12th St)	$503,326
21	Hull Ave (Frank St to ~350 ft North of Edwards Ave)	$152,862
22	Klock Rd (Water Plant to East)	$460,755
23	North Shore Dr (Klock Rd to North)	$167,847
24	West of Paw Paw Ave between Waukonda Ave and Frank St	$266,980
25	Building Lot (Water St to 2nd St)	$177,759
26	Maple St (Pipestone St to Cedar St)	$200,361
27	Riverview Dr and River St	$142,862
28	9th St, Britain Ave to South	$227,755
29	Brunson Ave (Hornack Rd to Jefferson St)	$178,681
30	Weld St (Union St to Agard Ave)	$91,555
31	4th St (Territorial Rd to Main St)	$99,025
20 Year Water Distribution CIP from Criticality Estimate		**$15,034,278**

Table 18: Water Distribution 20 Year CIP from Reliability Study (2033-2037)

#	Location Description	Estimated Construction Cost
1	Jean Klock Blvd (Grand Blvd to Hydrant) Grand Blvd (Hydrant to End)	$2,583,465
2	Waukonda (Loop 12" with 6" far E end)	$18,375
3	Nowlen (Waukonda to Madison) Madison (N McCord to Nowlen) Winans (Madison to LaSalle)	$1,514,235
4	N Fair (Wauceda to LaSalle)	$492,720
5	Hull (1st Hydrant)	$126,525

6	NE Whirlpool Hydrant (Hinkley to Benton Harbor Tech Center)*	$0
7	Hinkley (8th to Bend)	$493,500
8	N Seeley (76' S of Main to hydrant)*	$0
9	N Fair (100' S of Main to hydrant)*	$0
10	Highland (Cass to Winans) Nowlen (Highland to Cass)	$458,070
11	Highland (Seeley to 37' N on Fair)	$582,465
12	Thresher (Hull to McCord) S Winans (Thresher to Buss)	$744,960
13	Fair (Thresher to Vineyard) High (McCord to Fair)	$1,715,355
14	Ohio (Bellview to Hydrant)	$157,500
15	Pleasant (Bellview to Pipestone)	$488,550
16	Thayer Ct (Bellview to Hydrant)	$100,800
17	Colby (Pipestone to Hydrant)	$132,675
18	Ohio (W Britain to Hydrant)*	$0
19	Cedar (Cherry to Britain)	$207,900
20	Apple (Hydrant to McAllister)	$249,540
21	Foster (Superior to Columbus)	$193,200
22	Plummer Ct (Pipestone to Heck)	$167,670
23	Catalpa (Columbus to Pipestone)	$748,335
24	Kline (Colfax to McAllister)	$604,800
25	9th St (2nd Hydrant to Apartment Complex)	$576,450
26	Harrison (Colfax to Broadway)	$561,660
27	Division (Pipestone to Columbus) Columbus (Empire to Division)	$1,842,840
28	Niles (Pipestone to Monroe)	$473,355
29	Clay (Lavette to Broadway)	$654,015
30	Clay (Colfax to End)	$15,750
31	Agard (Loop onto Pipestone)	$84,000
32	Weld (Union to Hurd)*	$0
33	Cross (Colfax to McAllister)	$574,200
34	Colfax (Windsor to Emery)	$375,480
20 Year Water Distribution CIP from Reliability Estimate		**$16,938,390**

**Cost omitted because already part of Criticality CIP Costs*

6.3 CIP Plan Summary

In summary, as seen below in Tables 19 & 20, for both the five (5) and twenty (20) year CIP plans, an estimated total in excess of $51 million dollars will be needed to address issues with the water system, particularly to replace aging materials that are reaching the end of their useful life.

Table 19: 5 Year Water CIP Plan Summary

Overall 5 Year Water CIP Plan Summary	Estimated Construction Cost
Water Supply	$1,000,000
Water Storage	$319,800
Water Distribution – Criticality Ratings	$6,559,035
Water Distribution - Reliability Study	$7,919,955
Overall 5 Year Water CIP Estimate Summary	**$15,798,790**

Table 20: 20 Year Water CIP Plan Summary

Overall 20 Year Water CIP Plan Summary	Estimated Construction Cost
Water Supply	$500,000
Water Storage	$3,000,000
Water Distribution – Criticality Ratings	$15,034,278
Water Distribution - Reliability Study	$16,938,390
Overall 20 Year Water CIP Estimate Summary	**$35,472,668**

7 Conclusions

Overall, the City of Benton Harbor has an aging water infrastructure network, similar to many other communities, which will require continual investment to ensure that it meets both State and Federal requirements as well as the City's specific operating goals. The level of investment for both the five (5) year and twenty (20) year CIP plans should be implemented to ensure that the existing water quality and reliability is maintained and improved within the network. These projects should be coordinated with sewer and roadway projects identified in the SAW funded - Sewer Asset Management Plan and the soon-to-be completed Street Asset Management Plan.

As stated in the MDEQ guidance document, asset management is a systematic process of operating, maintaining, and upgrading assets cost-effectively. It is an active, on-going

process that provides information to managers in order to make sound decisions about their capital assets and allows decision makers to better identify and manage needed investments in their utility's infrastructure. This asset management plan should be updated yearly to reflect changes to the asset inventory, criticality analysis and progress on the capital improvement projects. Thoroughly updating this document regularly is more efficient than trying to figure out what happened years ago and having to make large updates.

Once the most cost effective funding solution has been determined, the city can proceed with adjustments to rates to cover the necessary costs. In the short term it would be beneficial for the city to reinstate the 5% rate increase that was reduced in 2013. A 15% rate increase may be needed in early 2018 to cover current and expected debt service requirements. Due to the large amount of funding necessary to complete the improvements identified, it is expected that the city will complete large projects together and be required to finance them over a long-term with rates adjusted accordingly. Grants should be utilized to the maximum extent possible to minimize impact on users.

Once the improvements outlined in this plan are completed, it should be anticipated that other assets will be reaching the end of their expected effective life, requiring further investment. Benton Harbor is nearing the end of its first generation of water infrastructure with other generations following closely behind.

APPENDIX A

BENTON HARBOR WATER DISTRIBUTION PIPE CONDITION SUMMARY TABLE

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00144	Cast Iron, Assumed	2"	24.0	1909	108	1	0	0.1	75	3.5	10.0	35.0	1.0	0
WMAIN-00146	Cast Iron, Assumed	2"	234.8	1909	108	1	0	0.1	75	3.5	10.0	35.0	1.0	0
WMAIN-00272	Cast Iron, Assumed	2"	293.7	1909	108	0.8	0.8	0.1	75	4.5	10.0	45.0	1.0	0
WMAIN-00512	Cast Iron, Assumed	2"	22.0	1909	108	1	0	0.1	75	3.5	10.0	35.0	1.0	0
WMAIN-00513	Cast Iron, Assumed	2"	31.7	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01088	Cast Iron, Assumed	2"	164.3	1909	108	0.8	0	0.1	75	2.9	10.0	29.0	1.0	0
WMAIN-00003	Cast Iron, Assumed	4"	279.6	1956	61	0.8	0	0.4	75	4.4	8.1	35.8	0.8	14
WMAIN-00005	Cast Iron, Assumed	4"	563.4	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00006	Cast Iron, Assumed	4"	611.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00010	Cast Iron, Assumed	4"	327.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00024	Cast Iron, Assumed	4"	485.4	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00025	Cast Iron, Assumed	4"	344.7	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00026	Cast Iron, Assumed	4"	404.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00027	Cast Iron, Assumed	4"	4.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00028	Cast Iron, Assumed	4"	326.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00029	Cast Iron, Assumed	4"	327.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00030	Cast Iron, Assumed	4"	979.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00035	Cast Iron, Assumed	4"	6.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00036	Cast Iron, Assumed	4"	71.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00037	Cast Iron, Assumed	4"	311.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00039	Cast Iron, Assumed	4"	452.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00042	Cast Iron, Assumed	4"	249.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00053	Cast Iron, Assumed	4"	546.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00054	Cast Iron, Assumed	4"	314.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00055	Cast Iron, Assumed	4"	657.1	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00069	Cast Iron, Assumed	4"	299.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00070	Cast Iron, Assumed	4"	543.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00071	Cast Iron, Assumed	4"	918.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00076	Cast Iron, Assumed	4"	39.2	1940	77	0	0	0.4	75	2	10.0	20.0	1.0	0
WMAIN-00090	Cast Iron, Assumed	4"	366.1	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00118	Cast Iron, Assumed	4"	24.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00119	Cast Iron, Assumed	4"	79.7	1909	108	0.2	1	0.4	75	4.6	10.0	46.0	1.0	0
WMAIN-00120	Cast Iron, Assumed	4"	105.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00121	Cast Iron, Assumed	4"	5.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00131	Cast Iron, Assumed	4"	266.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00141	Cast Iron, Assumed	4"	636.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00142	Cast Iron, Assumed	4"	5.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00143	Cast Iron, Assumed	4"	281.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00159	Cast Iron, Assumed	4"	56.4	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00161	Cast Iron, Assumed	4"	33.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00162	Cast Iron, Assumed	4"	445.3	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00165	Cast Iron, Assumed	4"	495.6	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00166	Cast Iron, Assumed	4"	332.8	1959	58	0.8	0	0.4	75	4.4	7.7	34.0	0.8	17
WMAIN-00169	Cast Iron, Assumed	4"	328.0	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-00175	Cast Iron, Assumed	4"	162.1	1909	108	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00176	Cast Iron, Assumed	4"	15.1	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00179	Cast Iron, Assumed	4"	40.5	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00180	Cast Iron, Assumed	4"	14.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00188	Cast Iron, Assumed	4"	254.4	1909	108	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00189	Cast Iron, Assumed	4"	310.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00197	Cast Iron, Assumed	4"	327.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00198	Cast Iron, Assumed	4"	336.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00199	Cast Iron, Assumed	4"	309.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00200	Cast Iron, Assumed	4"	317.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00205	Cast Iron, Assumed	4"	70.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00208	Cast Iron, Assumed	4"	305.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00219	Cast Iron, Assumed	4"	5.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00222	Cast Iron, Assumed	4"	357.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00223	Cast Iron, Assumed	4"	43.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00224	Cast Iron, Assumed	4"	705.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00225	Cast Iron, Assumed	4"	425.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00229	Cast Iron, Assumed	4"	7.0	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-00230	Cast Iron, Assumed	4"	46.0	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-00231	Cast Iron, Assumed	4"	298.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00232	Cast Iron, Assumed	4"	637.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00235	Cast Iron, Assumed	4"	287.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00239	Cast Iron, Assumed	4"	335.0	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00240	Cast Iron, Assumed	4"	377.2	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00241	Cast Iron, Assumed	4"	594.0	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00249	Cast Iron, Assumed	4"	186.2	1909	108	0	0	0.4	75	2	10.0	20.0	1.0	0
WMAIN-00250	Cast Iron, Assumed	4"	3.0	1909	108	0	0	0.4	75	2	10.0	20.0	1.0	0
WMAIN-00251	Cast Iron, Assumed	4"	455.7	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00255	Cast Iron, Assumed	4"	585.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00258	Cast Iron, Assumed	4"	311.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00259	Cast Iron, Assumed	4"	95.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00264	Cast Iron, Assumed	4"	128.7	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00265	Cast Iron, Assumed	4"	299.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00266	Cast Iron, Assumed	4"	120.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00268	Cast Iron, Assumed	4"	18.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00269	Cast Iron, Assumed	4"	1058.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00270	Cast Iron, Assumed	4"	398.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00271	Cast Iron, Assumed	4"	358.7	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00273	Cast Iron, Assumed	4"	732.3	1909	108	1	0.5	0.4	75	6	10.0	60.0	1.0	0
WMAIN-00275	Cast Iron, Assumed	4"	452.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00279	Cast Iron, Assumed	4"	42.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00280	Cast Iron, Assumed	4"	640.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00282	Cast Iron, Assumed	4"	196.7	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00283	Cast Iron, Assumed	4"	1313.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00284	Cast Iron, Assumed	4"	196.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00285	Cast Iron, Assumed	4"	631.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00286	Cast Iron, Assumed	4"	697.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00287	Cast Iron, Assumed	4"	665.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00289	Cast Iron, Assumed	4"	214.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00290	Cast Iron, Assumed	4"	523.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00291	Cast Iron, Assumed	4"	453.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00292	Cast Iron, Assumed	4"	28.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00293	Cast Iron, Assumed	4"	785.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00294	Cast Iron, Assumed	4"	334.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00295	Cast Iron, Assumed	4"	328.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00296	Cast Iron, Assumed	4"	310.8	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00297	Cast Iron, Assumed	4"	654.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00298	Cast Iron, Assumed	4"	660.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00299	Cast Iron, Assumed	4"	653.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00300	Cast Iron, Assumed	4"	344.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00301	Cast Iron, Assumed	4"	344.8	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00309	Cast Iron, Assumed	4"	297.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00310	Cast Iron, Assumed	4"	316.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00311	Cast Iron, Assumed	4"	627.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00312	Cast Iron, Assumed	4"	895.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00313	Cast Iron, Assumed	4"	74.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00317	Cast Iron, Assumed	4"	610.7	Pre-1949	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00333	Cast Iron, Assumed	4"	633.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00334	Cast Iron, Assumed	4"	294.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00337	Cast Iron, Assumed	4"	312.8	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00338	Cast Iron, Assumed	4"	184.4	1940	77	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00339	Cast Iron, Assumed	4"	918.8	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00347	Cast Iron, Assumed	4"	349.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00354	Cast Iron, Assumed	4"	41.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00356	Cast Iron, Assumed	4"	59.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00361	Cast Iron, Assumed	4"	644.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00362	Cast Iron, Assumed	4"	329.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00363	Cast Iron, Assumed	4"	309.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00364	Cast Iron, Assumed	4"	546.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00367	Cast Iron, Assumed	4"	264.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00368	Cast Iron, Assumed	4"	522.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00375	Cast Iron, Assumed	4"	45.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00376	Cast Iron, Assumed	4"	1293.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00380	Cast Iron, Assumed	4"	102.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00381	Cast Iron, Assumed	4"	659.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00392	Cast Iron, Assumed	4"	60.7	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00394	Cast Iron, Assumed	4"	300.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00402	Cast Iron, Assumed	4"	200.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00403	Cast Iron, Assumed	4"	411.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00405	Cast Iron, Assumed	4"	9.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00406	Cast Iron, Assumed	4"	540.7	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00407	Cast Iron, Assumed	4"	28.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00408	Cast Iron, Assumed	4"	330.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00409	Cast Iron, Assumed	4"	607.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00410	Cast Iron, Assumed	4"	240.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00411	Cast Iron, Assumed	4"	909.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00412	Cast Iron, Assumed	4"	3.0	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-00413	Cast Iron, Assumed	4"	389.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00414	Cast Iron, Assumed	4"	73.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00422	Cast Iron, Assumed	4"	697.6	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00424	Cast Iron, Assumed	4"	658.1	1950	67	1	0.5	0.4	75	6	8.9	53.6	0.9	8
WMAIN-00430	Cast Iron, Assumed	4"	8.9	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00452	Cast Iron, Assumed	4"	11.6	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00486	Cast Iron, Assumed	4"	145.1	1909	108	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00487	Cast Iron, Assumed	4"	310.7	1909	108	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00510	Cast Iron, Assumed	4"	546.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00522	Cast Iron, Assumed	4"	108.2	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00526	Cast Iron, Assumed	4"	918.5	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00527	Cast Iron, Assumed	4"	294.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00530	Cast Iron, Assumed	4"	37.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00531	Cast Iron, Assumed	4"	599.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00533	Cast Iron, Assumed	4"	31.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00540	Cast Iron, Assumed	4"	813.2	1959	58	0.8	0	0.4	75	4.4	7.7	34.0	0.8	17
WMAIN-00546	Cast Iron, Assumed	4"	388.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00548	Cast Iron, Assumed	4"	461.5	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00557	Cast Iron, Assumed	4"	140.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00561	Cast Iron, Assumed	4"	468.1	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00562	Cast Iron, Assumed	4"	418.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00563	Cast Iron, Assumed	4"	46.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00564	Cast Iron, Assumed	4"	282.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00565	Cast Iron, Assumed	4"	28.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00566	Cast Iron, Assumed	4"	11.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00568	Cast Iron, Assumed	4"	67.7	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-00571	Cast Iron, Assumed	4"	1.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00572	Cast Iron, Assumed	4"	357.8	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00574	Cast Iron, Assumed	4"	44.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00575	Cast Iron, Assumed	4"	546.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00576	Cast Iron, Assumed	4"	217.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00577	Cast Iron, Assumed	4"	465.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00578	Cast Iron, Assumed	4"	29.8	1909	108	0.8	1	0.4	75	6.4	10.0	64.0	1.0	0
WMAIN-00579	Cast Iron, Assumed	4"	288.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00581	Cast Iron, Assumed	4"	155.6	Pre-1952	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00590	Cast Iron, Assumed	4"	495.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00601	Cast Iron, Assumed	4"	90.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00602	Cast Iron, Assumed	4"	575.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00603	Cast Iron, Assumed	4"	583.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00609	Cast Iron, Assumed	4"	576.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00610	Cast Iron, Assumed	4"	16.1	1909	108	0.3	0	0.4	75	2.9	10.0	29.0	1.0	0
WMAIN-00617	Cast Iron, Assumed	4"	36.3	1909	108	0.3	0	0.4	75	2.9	10.0	29.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00620	Cast Iron, Assumed	4"	453.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00630	Cast Iron, Assumed	4"	125.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00631	Cast Iron, Assumed	4"	12.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00636	Cast Iron, Assumed	4"	293.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00638	Cast Iron, Assumed	4"	294.4	1909	108	0.2	1	0.4	75	4.6	10.0	46.0	1.0	0
WMAIN-00641	Cast Iron, Assumed	4"	80.7	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00642	Cast Iron, Assumed	4"	2.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00643	Cast Iron, Assumed	4"	9.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00644	Cast Iron, Assumed	4"	9.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00647	Cast Iron, Assumed	4"	9.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00650	Cast Iron, Assumed	4"	316.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00661	Cast Iron, Assumed	4"	189.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00662	Cast Iron, Assumed	4"	97.4	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00666	Cast Iron, Assumed	4"	1009.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00669	Cast Iron, Assumed	4"	201.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00672	Cast Iron, Assumed	4"	319.2	Pre-1952	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00682	Cast Iron, Assumed	4"	13.0	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00685	Cast Iron, Assumed	4"	41.5	1934	83	0	0	0.4	75	2	10.0	20.0	1.0	0
WMAIN-00686	Cast Iron, Assumed	4"	68.2	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00691	Cast Iron, Assumed	4"	258.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00699	Cast Iron, Assumed	4"	5.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00704	Cast Iron, Assumed	4"	47.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00705	Cast Iron, Assumed	4"	9.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00709	Cast Iron, Assumed	4"	43.7	1909	108	0.8	0.5	0.4	75	5.4	10.0	54.0	1.0	0
WMAIN-00717	Cast Iron, Assumed	4"	874.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00727	Cast Iron, Assumed	4"	257.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00728	Cast Iron, Assumed	4"	426.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00730	Cast Iron, Assumed	4"	162.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00739	Cast Iron, Assumed	4"	817.9	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00764	Cast Iron, Assumed	4"	27.1	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00765	Cast Iron, Assumed	4"	39.2	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00766	Cast Iron, Assumed	4"	9.3	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00777	Cast Iron, Assumed	4"	504.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00788	Cast Iron, Assumed	4"	31.6	1909	108	0.8	0.5	0.4	75	5.4	10.0	54.0	1.0	0
WMAIN-00789	Cast Iron, Assumed	4"	164.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00806	Cast Iron, Assumed	4"	300.1	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00807	Cast Iron, Assumed	4"	194.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00808	Cast Iron, Assumed	4"	189.6	1969	48	1	0	0.4	75	5	6.4	32.0	0.6	27
WMAIN-00836	Cast Iron, Assumed	4"	229.8	1947	70	0.2	0	0.4	75	2.6	9.3	24.3	0.9	5
WMAIN-00845	Cast Iron, Assumed	4"	426.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00850	Cast Iron, Assumed	4"	99.5	Pre-1969	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00851	Cast Iron, Assumed	4"	52.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00852	Cast Iron, Assumed	4"	256.3	1909	108	0	0	0.4	75	2	10.0	20.0	1.0	0
WMAIN-00912	Cast Iron, Assumed	4"	242.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00913	Cast Iron, Assumed	4"	61.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00914	Cast Iron, Assumed	4"	444.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00944	Cast Iron, Assumed	4"	257.0	1940	77	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00980	Cast Iron, Assumed	4"	345.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00982	Cast Iron, Assumed	4"	371.0	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00997	Cast Iron, Assumed	4"	225.9	1950	67	0.3	0	0.4	75	2.9	8.9	25.9	0.9	8
WMAIN-01020	Cast Iron, Assumed	4"	298.1	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01021	Cast Iron, Assumed	4"	389.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01022	Cast Iron, Assumed	4"	92.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01023	Cast Iron, Assumed	4"	85.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01028	Cast Iron, Assumed	4"	156.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01029	Cast Iron, Assumed	4"	461.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01049	Cast Iron, Assumed	4"	161.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01050	Cast Iron, Assumed	4"	46.3	1909	108	0.3	1	0.4	75	4.9	10.0	49.0	1.0	0
WMAIN-01077	Cast Iron, Assumed	4"	278.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01078	Cast Iron, Assumed	4"	130.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01089	Cast Iron, Assumed	4"	689.4	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0

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WMAIN-01090	Cast Iron, Assumed	4"	302.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01100	Cast Iron, Assumed	4"	335.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01108	Cast Iron, Assumed	4"	3.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01110	Cast Iron, Assumed	4"	26.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01111	Cast Iron, Assumed	4"	67.7	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01171	Cast Iron, Assumed	4"	24.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01247	Cast Iron, Assumed	4"	206.4	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01265	Cast Iron, Assumed	4"	22.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01315	Cast Iron, Assumed	4"	227.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01325	Cast Iron, Assumed	4"	675.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01326	Cast Iron, Assumed	4"	32.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01327	Cast Iron, Assumed	4"	45.8	1937	80	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01328	Cast Iron, Assumed	4"	35.2	1937	80	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01329	Cast Iron, Assumed	4"	250.5	1937	80	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01350	Cast Iron, Assumed	4"	35.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01474	Cast Iron, Assumed	4"	20.9	Pre-1952	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01475	Cast Iron, Assumed	4"	22.5	Pre-1949	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01476	Cast Iron, Assumed	4"	23.2	Pre-1949	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01493	Cast Iron, Assumed	4"	45.7	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-01519	Cast Iron, Assumed	4"	25.7	1909	108	0.8	0.5	0.4	75	5.4	10.0	54.0	1.0	0
WMAIN-01545	Cast Iron, Assumed	4"	5.8	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01546	Cast Iron, Assumed	4"	3.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01618	Cast Iron, Assumed	4"	11.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01620	Cast Iron, Assumed	4"	7.7	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01621	Cast Iron, Assumed	4"	10.3	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01628	Cast Iron, Assumed	4"	32.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01630	Cast Iron, Assumed	4"	41.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01632	Cast Iron, Assumed	4"	39.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01638	Cast Iron, Assumed	4"	17.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01639	Cast Iron, Assumed	4"	38.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01640	Cast Iron, Assumed	4"	3.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01643	Cast Iron, Assumed	4"	2.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01654	Cast Iron, Assumed	4"	131.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01655	Cast Iron, Assumed	4"	4.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01660	Cast Iron, Assumed	4"	46.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01662	Cast Iron, Assumed	4"	428.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01664	Cast Iron, Assumed	4"	46.6	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-01667	Cast Iron, Assumed	4"	306.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01668	Cast Iron, Assumed	4"	54.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01669	Cast Iron, Assumed	4"	11.0	1909	108	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-01672	Cast Iron, Assumed	4"	37.8	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01673	Cast Iron, Assumed	4"	30.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01677	Cast Iron, Assumed	4"	144.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01682	Cast Iron, Assumed	4"	29.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01684	Cast Iron, Assumed	4"	8.9	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01685	Cast Iron, Assumed	4"	5.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01686	Cast Iron, Assumed	4"	26.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01687	Cast Iron, Assumed	4"	4.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01688	Cast Iron, Assumed	4"	5.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01693	Cast Iron, Assumed	4"	189.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01701	Cast Iron, Assumed	4"	30.8	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01721	Cast Iron, Assumed	4"	26.8	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01723	Cast Iron, Assumed	4"	157.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01724	Cast Iron, Assumed	4"	178.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01726	Cast Iron, Assumed	4"	115.0	Pre-1952	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01727	Cast Iron, Assumed	4"	97.9	Pre-1952	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01728	Cast Iron, Assumed	4"	22.6	Pre-1952	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01730	Cast Iron, Assumed	4"	51.6	Pre-1952	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01737	Cast Iron, Assumed	4"	80.7	Pre-1947	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01738	Cast Iron, Assumed	4"	7.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00221	Cast Iron, Assumed	4"	35.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-01742	Ductile Iron	4"	22.6	2008	9	0.8	0	0.4	90	4.4	1.0	4.4	0.1	81
WMAIN-01743	Ductile Iron	4"	20.3	2008	9	0.8	0	0.4	90	4.4	1.0	4.4	0.1	81
WMAIN-01745	Ductile Iron	4"	15.6	2008	9	0.8	0	0.4	90	4.4	1.0	4.4	0.1	81
<Null>	Ductile Iron	4"	5.9	2015	2	1	0	0.4	90	5	0.2	1.1	0.0	88
WMAIN-00046	Ductile Iron, Assumed	4"	124.2	2008	9	1	0	0.4	90	5	1.0	5.0	0.1	81
WMAIN-00211	Ductile Iron, Assumed	4"	442.5	2006	11	0.8	0	0.4	90	4.4	1.2	5.4	0.1	79
WMAIN-00350	Ductile Iron, Assumed	4"	578.9	1980	37	0.8	0	0.4	90	4.4	4.1	18.1	0.4	53
WMAIN-00586	Ductile Iron, Assumed	4"	448.2	1974	43	0.8	0	0.4	90	4.4	4.8	21.0	0.5	47
WMAIN-00744	Ductile Iron, Assumed	4"	45.6	1974	43	0.8	0	0.4	90	4.4	4.8	21.0	0.5	47
WMAIN-00746	Ductile Iron, Assumed	4"	3.8	1974	43	0.8	0	0.4	90	4.4	4.8	21.0	0.5	47
WMAIN-00748	Ductile Iron, Assumed	4"	807.6	2008	9	0.8	0	0.4	90	4.4	1.0	4.4	0.1	81
WMAIN-00760	Ductile Iron, Assumed	4"	377.9	1971	46	1	0	0.4	90	5	5.1	25.6	0.5	44
WMAIN-01692	Ductile Iron, Assumed	4"	3.1	1974	43	0.8	0	0.4	90	4.4	4.8	21.0	0.5	47
WMAIN-00007	Cast Iron, Assumed	6"	662.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00008	Cast Iron, Assumed	6"	51.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00009	Cast Iron, Assumed	6"	281.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00011	Cast Iron, Assumed	6"	16.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00012	Cast Iron, Assumed	6"	332.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00013	Cast Iron, Assumed	6"	354.4	1956	61	0.8	0	0.4	75	4.4	8.1	35.8	0.8	14
WMAIN-00018	Cast Iron, Assumed	6"	680.7	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00019	Cast Iron, Assumed	6"	44.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00021	Cast Iron, Assumed	6"	9.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00022	Cast Iron, Assumed	6"	69.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00023	Cast Iron, Assumed	6"	489.0	1937	80	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00031	Cast Iron, Assumed	6"	3.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00032	Cast Iron, Assumed	6"	3.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00033	Cast Iron, Assumed	6"	412.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00034	Cast Iron, Assumed	6"	88.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00047	Cast Iron, Assumed	6"	269.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00050	Cast Iron, Assumed	6"	241.3	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00051	Cast Iron, Assumed	6"	613.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00052	Cast Iron, Assumed	6"	295.7	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00056	Cast Iron, Assumed	6"	1273.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00057	Cast Iron, Assumed	6"	336.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00058	Cast Iron, Assumed	6"	332.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00059	Cast Iron, Assumed	6"	664.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00060	Cast Iron, Assumed	6"	656.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00061	Cast Iron, Assumed	6"	329.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00067	Cast Iron, Assumed	6"	634.8	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00068	Cast Iron, Assumed	6"	60.1	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00078	Cast Iron, Assumed	6"	39.5	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-00083	Cast Iron, Assumed	6"	10.7	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-00092	Cast Iron, Assumed	6"	432.1	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00093	Cast Iron, Assumed	6"	826.6	1959	58	0.8	0	0.4	75	4.4	7.7	34.0	0.8	17
WMAIN-00094	Cast Iron, Assumed	6"	1362.1	1969	48	0.8	0	0.4	75	4.4	6.4	28.2	0.6	27
WMAIN-00108	Cast Iron, Assumed	6"	295.9	1937	80	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00109	Cast Iron, Assumed	6"	14.3	1937	80	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00113	Cast Iron, Assumed	6"	450.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00122	Cast Iron, Assumed	6"	173.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00123	Cast Iron, Assumed	6"	21.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00124	Cast Iron, Assumed	6"	100.5	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00129	Cast Iron, Assumed	6"	12.3	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00136	Cast Iron, Assumed	6"	220.5	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00138	Cast Iron, Assumed	6"	149.5	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00139	Cast Iron, Assumed	6"	384.7	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00140	Cast Iron, Assumed	6"	179.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00148	Cast Iron, Assumed	6"	207.2	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00163	Cast Iron, Assumed	6"	58.0	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00164	Cast Iron, Assumed	6"	72.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00168	Cast Iron, Assumed	6"	220.1	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-00170	Cast Iron, Assumed	6"	334.8	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00171	Cast Iron, Assumed	6"	494.4	1979	38	1	0	0.4	75	5	5.1	25.3	0.5	37
WMAIN-00182	Cast Iron, Assumed	6"	10.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00183	Cast Iron, Assumed	6"	19.0	1909	108	0.3	0	0.4	75	2.9	10.0	29.0	1.0	0
WMAIN-00184	Cast Iron, Assumed	6"	15.0	1909	108	0.3	0	0.4	75	2.9	10.0	29.0	1.0	0
WMAIN-00185	Cast Iron, Assumed	6"	27.7	1909	108	0.3	0	0.4	75	2.9	10.0	29.0	1.0	0
WMAIN-00186	Cast Iron, Assumed	6"	29.9	1909	108	0.3	0	0.4	75	2.9	10.0	29.0	1.0	0
WMAIN-00187	Cast Iron, Assumed	6"	192.2	1909	108	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00190	Cast Iron, Assumed	6"	806.7	1978	39	1	0	0.4	75	5	5.2	26.0	0.5	36
WMAIN-00191	Cast Iron, Assumed	6"	296.3	1979	38	1	0	0.4	75	5	5.1	25.3	0.5	37
WMAIN-00192	Cast Iron, Assumed	6"	1313.0	1978	39	1	0	0.4	75	5	5.2	26.0	0.5	36
WMAIN-00193	Cast Iron, Assumed	6"	514.3	1978	39	1	0	0.4	75	5	5.2	26.0	0.5	36
WMAIN-00194	Cast Iron, Assumed	6"	25.1	1978	39	1	0	0.4	75	5	5.2	26.0	0.5	36
WMAIN-00202	Cast Iron, Assumed	6"	1341.1	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00203	Cast Iron, Assumed	6"	672.4	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00204	Cast Iron, Assumed	6"	80.2	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00206	Cast Iron, Assumed	6"	308.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00207	Cast Iron, Assumed	6"	181.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00218	Cast Iron, Assumed	6"	253.8	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00233	Cast Iron, Assumed	6"	491.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00234	Cast Iron, Assumed	6"	479.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00247	Cast Iron, Assumed	6"	188.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00252	Cast Iron, Assumed	6"	869.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00253	Cast Iron, Assumed	6"	11.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00256	Cast Iron, Assumed	6"	259.1	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00263	Cast Iron, Assumed	6"	55.7	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00267	Cast Iron, Assumed	6"	1240.7	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00276	Cast Iron, Assumed	6"	20.3	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00277	Cast Iron, Assumed	6"	589.3	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00278	Cast Iron, Assumed	6"	168.7	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00288	Cast Iron, Assumed	6"	22.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00302	Cast Iron, Assumed	6"	330.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00303	Cast Iron, Assumed	6"	331.1	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00304	Cast Iron, Assumed	6"	306.7	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00305	Cast Iron, Assumed	6"	412.9	Pre-1947	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00306	Cast Iron, Assumed	6"	211.3	Pre-1947	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00307	Cast Iron, Assumed	6"	100.4	Pre-1947	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00308	Cast Iron, Assumed	6"	542.7	Pre-1947	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00314	Cast Iron, Assumed	6"	8.8	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00315	Cast Iron, Assumed	6"	39.1	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00316	Cast Iron, Assumed	6"	47.6	Pre-1949	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00318	Cast Iron, Assumed	6"	61.4	Pre-1947	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00320	Cast Iron, Assumed	6"	301.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00321	Cast Iron, Assumed	6"	1306.7	Pre-1947	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00322	Cast Iron, Assumed	6"	625.6	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-00323	Cast Iron, Assumed	6"	1322.3	Pre-1949	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00332	Cast Iron, Assumed	6"	708.1	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00335	Cast Iron, Assumed	6"	173.1	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00336	Cast Iron, Assumed	6"	10.1	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00340	Cast Iron, Assumed	6"	730.7	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00341	Cast Iron, Assumed	6"	207.5	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00342	Cast Iron, Assumed	6"	295.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00343	Cast Iron, Assumed	6"	341.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00346	Cast Iron, Assumed	6"	668.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00348	Cast Iron, Assumed	6"	691.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00349	Cast Iron, Assumed	6"	673.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00351	Cast Iron, Assumed	6"	655.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00352	Cast Iron, Assumed	6"	297.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00353	Cast Iron, Assumed	6"	281.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00355	Cast Iron, Assumed	6"	120.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00365	Cast Iron, Assumed	6"	671.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00366	Cast Iron, Assumed	6"	679.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00370	Cast Iron, Assumed	6"	684.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00371	Cast Iron, Assumed	6"	427.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00372	Cast Iron, Assumed	6"	1285.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00373	Cast Iron, Assumed	6"	627.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00374	Cast Iron, Assumed	6"	657.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00377	Cast Iron, Assumed	6"	832.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00378	Cast Iron, Assumed	6"	650.6	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00379	Cast Iron, Assumed	6"	669.3	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00382	Cast Iron, Assumed	6"	664.9	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00387	Cast Iron, Assumed	6"	660.6	Pre-1967	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00393	Cast Iron, Assumed	6"	180.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00395	Cast Iron, Assumed	6"	366.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00396	Cast Iron, Assumed	6"	561.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00397	Cast Iron, Assumed	6"	327.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00398	Cast Iron, Assumed	6"	10.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00399	Cast Iron, Assumed	6"	37.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00400	Cast Iron, Assumed	6"	23.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00401	Cast Iron, Assumed	6"	39.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00404	Cast Iron, Assumed	6"	84.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00425	Cast Iron, Assumed	6"	145.5	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00433	Cast Iron, Assumed	6"	366.6	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00434	Cast Iron, Assumed	6"	6.0	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00435	Cast Iron, Assumed	6"	207.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00436	Cast Iron, Assumed	6"	7.0	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00437	Cast Iron, Assumed	6"	26.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00439	Cast Iron, Assumed	6"	5.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00440	Cast Iron, Assumed	6"	10.3	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00441	Cast Iron, Assumed	6"	13.3	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00442	Cast Iron, Assumed	6"	59.1	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00443	Cast Iron, Assumed	6"	3.0	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00444	Cast Iron, Assumed	6"	9.4	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00445	Cast Iron, Assumed	6"	4.1	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00446	Cast Iron, Assumed	6"	0.7	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00447	Cast Iron, Assumed	6"	9.4	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00448	Cast Iron, Assumed	6"	56.8	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00450	Cast Iron, Assumed	6"	333.4	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00454	Cast Iron, Assumed	6"	658.8	Pre-1967	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00455	Cast Iron, Assumed	6"	2.0	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00456	Cast Iron, Assumed	6"	11.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00457	Cast Iron, Assumed	6"	10.3	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00462	Cast Iron, Assumed	6"	6.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00464	Cast Iron, Assumed	6"	722.7	Pre-1967	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00474	Cast Iron, Assumed	6"	4.6	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00475	Cast Iron, Assumed	6"	3.6	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00477	Cast Iron, Assumed	6"	5.2	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00478	Cast Iron, Assumed	6"	9.8	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00482	Cast Iron, Assumed	6"	660.7	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00484	Cast Iron, Assumed	6"	58.6	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00485	Cast Iron, Assumed	6"	8.5	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00490	Cast Iron, Assumed	6"	1294.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00492	Cast Iron, Assumed	6"	1301.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00493	Cast Iron, Assumed	6"	1329.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00494	Cast Iron, Assumed	6"	1347.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00495	Cast Iron, Assumed	6"	670.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00496	Cast Iron, Assumed	6"	1314.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00498	Cast Iron, Assumed	6"	125.0	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00499	Cast Iron, Assumed	6"	1026.3	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00500	Cast Iron, Assumed	6"	55.7	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00503	Cast Iron, Assumed	6"	37.7	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00511	Cast Iron, Assumed	6"	588.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00514	Cast Iron, Assumed	6"	36.3	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00515	Cast Iron, Assumed	6"	29.7	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00516	Cast Iron, Assumed	6"	7.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00519	Cast Iron, Assumed	6"	237.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00520	Cast Iron, Assumed	6"	69.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00521	Cast Iron, Assumed	6"	6.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00523	Cast Iron, Assumed	6"	70.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00524	Cast Iron, Assumed	6"	179.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00525	Cast Iron, Assumed	6"	323.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00532	Cast Iron, Assumed	6"	478.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00534	Cast Iron, Assumed	6"	981.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00535	Cast Iron, Assumed	6"	303.8	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00536	Cast Iron, Assumed	6"	379.1	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00537	Cast Iron, Assumed	6"	64.0	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00538	Cast Iron, Assumed	6"	502.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00539	Cast Iron, Assumed	6"	336.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00541	Cast Iron, Assumed	6"	493.0	1959	58	0.8	0	0.4	75	4.4	7.7	34.0	0.8	17
WMAIN-00542	Cast Iron, Assumed	6"	9.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00543	Cast Iron, Assumed	6"	301.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00544	Cast Iron, Assumed	6"	170.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00545	Cast Iron, Assumed	6"	163.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00547	Cast Iron, Assumed	6"	13.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00549	Cast Iron, Assumed	6"	419.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00550	Cast Iron, Assumed	6"	326.1	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00551	Cast Iron, Assumed	6"	370.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00552	Cast Iron, Assumed	6"	285.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00553	Cast Iron, Assumed	6"	296.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00554	Cast Iron, Assumed	6"	351.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00555	Cast Iron, Assumed	6"	2.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00556	Cast Iron, Assumed	6"	114.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00558	Cast Iron, Assumed	6"	432.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00559	Cast Iron, Assumed	6"	153.9	Pre-1969	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00560	Cast Iron, Assumed	6"	34.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00567	Cast Iron, Assumed	6"	53.8	1909	108	0.2	1	0.4	75	4.6	10.0	46.0	1.0	0
WMAIN-00570	Cast Iron, Assumed	6"	120.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00580	Cast Iron, Assumed	6"	12.4	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00587	Cast Iron, Assumed	6"	105.0	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00588	Cast Iron, Assumed	6"	45.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00589	Cast Iron, Assumed	6"	876.7	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00597	Cast Iron, Assumed	6"	10.0	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00599	Cast Iron, Assumed	6"	36.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00600	Cast Iron, Assumed	6"	279.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00604	Cast Iron, Assumed	6"	12.7	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00611	Cast Iron, Assumed	6"	451.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00616	Cast Iron, Assumed	6"	1067.3	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00618	Cast Iron, Assumed	6"	89.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00619	Cast Iron, Assumed	6"	98.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00622	Cast Iron, Assumed	6"	626.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00623	Cast Iron, Assumed	6"	304.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00624	Cast Iron, Assumed	6"	257.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00632	Cast Iron, Assumed	6"	1035.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00633	Cast Iron, Assumed	6"	4.4	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-00634	Cast Iron, Assumed	6"	23.6	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-00637	Cast Iron, Assumed	6"	649.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00657	Cast Iron, Assumed	6"	11.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00658	Cast Iron, Assumed	6"	9.9	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00659	Cast Iron, Assumed	6"	16.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00660	Cast Iron, Assumed	6"	610.4	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00663	Cast Iron, Assumed	6"	1297.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00664	Cast Iron, Assumed	6"	311.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00665	Cast Iron, Assumed	6"	27.9	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-00667	Cast Iron, Assumed	6"	417.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0

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WMAIN-00668	Cast Iron, Assumed	6"	145.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00674	Cast Iron, Assumed	6"	312.1	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-00675	Cast Iron, Assumed	6"	321.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00678	Cast Iron, Assumed	6"	654.8	Pre-1967	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00680	Cast Iron, Assumed	6"	9.4	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00683	Cast Iron, Assumed	6"	480.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00687	Cast Iron, Assumed	6"	388.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00688	Cast Iron, Assumed	6"	84.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00689	Cast Iron, Assumed	6"	98.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00690	Cast Iron, Assumed	6"	104.7	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00692	Cast Iron, Assumed	6"	144.7	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00693	Cast Iron, Assumed	6"	50.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00696	Cast Iron, Assumed	6"	45.2	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00697	Cast Iron, Assumed	6"	55.3	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00707	Cast Iron, Assumed	6"	7.0	1909	108	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00708	Cast Iron, Assumed	6"	13.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00710	Cast Iron, Assumed	6"	743.6	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00711	Cast Iron, Assumed	6"	409.8	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00715	Cast Iron, Assumed	6"	39.9	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00718	Cast Iron, Assumed	6"	287.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00721	Cast Iron, Assumed	6"	10.0	Pre-1967	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00722	Cast Iron, Assumed	6"	7.7	1967	50	1	0	0.4	75	5	6.7	33.3	0.7	25
WMAIN-00723	Cast Iron, Assumed	6"	10.4	1967	50	1	0	0.4	75	5	6.7	33.3	0.7	25
WMAIN-00724	Cast Iron, Assumed	6"	3.0	1967	50	1	0	0.4	75	5	6.7	33.3	0.7	25
WMAIN-00725	Cast Iron, Assumed	6"	205.1	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00729	Cast Iron, Assumed	6"	50.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00731	Cast Iron, Assumed	6"	501.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00732	Cast Iron, Assumed	6"	593.1	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-00733	Cast Iron, Assumed	6"	319.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00736	Cast Iron, Assumed	6"	8.3	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00737	Cast Iron, Assumed	6"	8.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00740	Cast Iron, Assumed	6"	615.1	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00741	Cast Iron, Assumed	6"	300.1	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00743	Cast Iron, Assumed	6"	86.4	1959	58	0.2	0	0.4	75	2.6	7.7	20.1	0.8	17
WMAIN-00745	Cast Iron, Assumed	6"	211.4	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00749	Cast Iron, Assumed	6"	10.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00754	Cast Iron, Assumed	6"	9.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00755	Cast Iron, Assumed	6"	11.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00756	Cast Iron, Assumed	6"	391.5	1959	58	0.8	0	0.4	75	4.4	7.7	34.0	0.8	17
WMAIN-00757	Cast Iron, Assumed	6"	148.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00759	Cast Iron, Assumed	6"	13.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00775	Cast Iron, Assumed	6"	1122.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00776	Cast Iron, Assumed	6"	96.8	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00778	Cast Iron, Assumed	6"	57.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00794	Cast Iron, Assumed	6"	84.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00799	Cast Iron, Assumed	6"	24.0	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00800	Cast Iron, Assumed	6"	29.9	1909	108	0	0	0.4	75	2	10.0	20.0	1.0	0
WMAIN-00801	Cast Iron, Assumed	6"	16.5	1909	108	0	0	0.4	75	2	10.0	20.0	1.0	0
WMAIN-00802	Cast Iron, Assumed	6"	19.4	1909	108	0	0	0.4	75	2	10.0	20.0	1.0	0
WMAIN-00803	Cast Iron, Assumed	6"	23.4	1909	108	0	0	0.4	75	2	10.0	20.0	1.0	0
WMAIN-00834	Cast Iron, Assumed	6"	373.3	2005	11	0.8	0	0.4	75	4.4	1.5	6.5	0.1	64
WMAIN-00835	Cast Iron, Assumed	6"	850.0	1947	70	0.2	0	0.4	75	2.6	9.3	24.3	0.9	5
WMAIN-00838	Cast Iron, Assumed	6"	518.7	1947	70	0.2	0	0.4	75	2.6	9.3	24.3	0.9	5
WMAIN-00842	Cast Iron, Assumed	6"	116.2	1947	70	1	0	0.4	75	5	9.3	46.7	0.9	5
WMAIN-00844	Cast Iron, Assumed	6"	246.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00849	Cast Iron, Assumed	6"	87.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00853	Cast Iron, Assumed	6"	118.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00854	Cast Iron, Assumed	6"	25.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00855	Cast Iron, Assumed	6"	352.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00899	Cast Iron, Assumed	6"	10.4	1959	58	0.3	0	0.4	75	2.9	7.7	22.4	0.8	17
WMAIN-00900	Cast Iron, Assumed	6"	375.1	1959	58	0.3	0	0.4	75	2.9	7.7	22.4	0.8	17

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00915	Cast Iron, Assumed	6"	129.8	1959	58	0.3	0	0.4	75	2.9	7.7	22.4	0.8	17
WMAIN-00916	Cast Iron, Assumed	6"	64.8	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-00938	Cast Iron, Assumed	6"	21.4	1950	67	0	0	0.4	75	2	8.9	17.9	0.9	8
WMAIN-00939	Cast Iron, Assumed	6"	21.6	1950	67	0	0	0.4	75	2	8.9	17.9	0.9	8
WMAIN-00950	Cast Iron, Assumed	6"	62.3	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-00956	Cast Iron, Assumed	6"	277.9	1959	58	0.2	0	0.4	75	2.6	7.7	20.1	0.8	17
WMAIN-00957	Cast Iron, Assumed	6"	96.0	1934	83	0.2	0.5	0.4	75	3.6	10.0	36.0	1.0	0
WMAIN-00958	Cast Iron, Assumed	6"	186.4	1934	83	0.2	0.5	0.4	75	3.6	10.0	36.0	1.0	0
WMAIN-00959	Cast Iron, Assumed	6"	79.9	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00960	Cast Iron, Assumed	6"	40.5	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00961	Cast Iron, Assumed	6"	128.6	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00962	Cast Iron, Assumed	6"	20.0	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00963	Cast Iron, Assumed	6"	166.6	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00964	Cast Iron, Assumed	6"	19.7	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00965	Cast Iron, Assumed	6"	61.5	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00966	Cast Iron, Assumed	6"	246.6	1934	83	0.2	0.5	0.4	75	3.6	10.0	36.0	1.0	0
WMAIN-00967	Cast Iron, Assumed	6"	99.3	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00968	Cast Iron, Assumed	6"	6.0	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00969	Cast Iron, Assumed	6"	57.7	1934	83	0.2	0.5	0.4	75	3.6	10.0	36.0	1.0	0
WMAIN-00970	Cast Iron, Assumed	6"	25.4	1934	83	0.2	0.5	0.4	75	3.6	10.0	36.0	1.0	0
WMAIN-00971	Cast Iron, Assumed	6"	71.4	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00972	Cast Iron, Assumed	6"	109.5	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00973	Cast Iron, Assumed	6"	132.8	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00974	Cast Iron, Assumed	6"	4.4	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-00977	Cast Iron, Assumed	6"	367.2	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00978	Cast Iron, Assumed	6"	355.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00979	Cast Iron, Assumed	6"	343.7	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-00981	Cast Iron, Assumed	6"	203.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-00984	Cast Iron, Assumed	6"	857.3	1947	70	0.2	0	0.4	75	2.6	9.3	24.3	0.9	5
WMAIN-00988	Cast Iron, Assumed	6"	8.5	1947	70	0.2	0	0.4	75	2.6	9.3	24.3	0.9	5
WMAIN-00989	Cast Iron, Assumed	6"	4.0	1947	70	0.2	0	0.4	75	2.6	9.3	24.3	0.9	5
WMAIN-00992	Cast Iron, Assumed	6"	7.1	2005	11	0.8	0	0.4	75	4.4	1.5	6.5	0.1	64
WMAIN-00994	Cast Iron, Assumed	6"	98.9	1947	70	0	0	0.4	75	2	9.3	18.7	0.9	5
WMAIN-00995	Cast Iron, Assumed	6"	107.5	1950	67	0	0	0.4	75	2	8.9	17.9	0.9	8
WMAIN-00996	Cast Iron, Assumed	6"	23.8	1950	67	0	0	0.4	75	2	8.9	17.9	0.9	8
WMAIN-00998	Cast Iron, Assumed	6"	3.0	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-01002	Cast Iron, Assumed	6"	15.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01006	Cast Iron, Assumed	6"	225.6	1998	19	0.2	0	0.4	75	2.6	2.5	6.6	0.3	56
WMAIN-01007	Cast Iron, Assumed	6"	140.7	1998	19	0.2	0	0.4	75	2.6	2.5	6.6	0.3	56
WMAIN-01008	Cast Iron, Assumed	6"	349.2	1998	19	0.2	1	0.4	75	4.6	2.5	11.7	0.3	56
WMAIN-01016	Cast Iron, Assumed	6"	323.3	1909	108	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-01017	Cast Iron, Assumed	6"	141.0	1909	108	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-01018	Cast Iron, Assumed	6"	148.9	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01019	Cast Iron, Assumed	6"	48.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01035	Cast Iron, Assumed	6"	184.8	1950	67	0.2	0	0.4	75	2.6	8.9	23.2	0.9	8
WMAIN-01037	Cast Iron, Assumed	6"	368.6	1950	67	0.2	0	0.4	75	2.6	8.9	23.2	0.9	8
WMAIN-01038	Cast Iron, Assumed	6"	8.7	1950	67	0.2	0	0.4	75	2.6	8.9	23.2	0.9	8
WMAIN-01039	Cast Iron, Assumed	6"	82.8	1909	108	1	0.8	0.4	75	6.6	10.0	66.0	1.0	0
WMAIN-01044	Cast Iron, Assumed	6"	11.5	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01047	Cast Iron, Assumed	6"	215.1	1909	108	1	0.5	0.4	75	6	10.0	60.0	1.0	0
WMAIN-01048	Cast Iron, Assumed	6"	21.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01051	Cast Iron, Assumed	6"	13.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01068	Cast Iron, Assumed	6"	131.9	1950	67	0.2	1	0.4	75	4.6	8.9	41.1	0.9	8
WMAIN-01069	Cast Iron, Assumed	6"	738.2	1950	67	0.2	0	0.4	75	2.6	8.9	23.2	0.9	8
WMAIN-01070	Cast Iron, Assumed	6"	290.0	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-01073	Cast Iron, Assumed	6"	174.8	1950	67	0.2	0	0.4	75	2.6	8.9	23.2	0.9	8
WMAIN-01079	Cast Iron, Assumed	6"	805.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01080	Cast Iron, Assumed	6"	11.3	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-01081	Cast Iron, Assumed	6"	63.3	1959	58	0.2	0	0.4	75	2.6	7.7	20.1	0.8	17
WMAIN-01083	Cast Iron, Assumed	6"	156.7	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01086	Cast Iron, Assumed	6"	4.3	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-01087	Cast Iron, Assumed	6"	562.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01092	Cast Iron, Assumed	6"	672.1	Pre-1947	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01093	Cast Iron, Assumed	6"	50.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01094	Cast Iron, Assumed	6"	84.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01095	Cast Iron, Assumed	6"	413.8	1959	58	1	0.5	0.4	75	6	7.7	46.4	0.8	17
WMAIN-01096	Cast Iron, Assumed	6"	77.4	1959	58	0	0.5	0.4	75	3	7.7	23.2	0.8	17
WMAIN-01103	Cast Iron, Assumed	6"	8.8	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-01112	Cast Iron, Assumed	6"	137.9	1947	70	0.8	0	0.4	75	4.4	9.3	41.1	0.9	5
WMAIN-01113	Cast Iron, Assumed	6"	600.7	1959	58	0.2	0.5	0.4	75	3.6	7.7	27.8	0.8	17
WMAIN-01114	Cast Iron, Assumed	6"	658.2	1950	67	0	0	0.4	75	2	8.9	17.9	0.9	8
WMAIN-01128	Cast Iron, Assumed	6"	10.9	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01147	Cast Iron, Assumed	6"	4.9	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01150	Cast Iron, Assumed	6"	70.7	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01164	Cast Iron, Assumed	6"	3.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01168	Cast Iron, Assumed	6"	15.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01173	Cast Iron, Assumed	6"	21.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01174	Cast Iron, Assumed	6"	34.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01212	Cast Iron, Assumed	6"	34.4	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01214	Cast Iron, Assumed	6"	166.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01249	Cast Iron, Assumed	6"	6.5	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01253	Cast Iron, Assumed	6"	204.5	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01254	Cast Iron, Assumed	6"	142.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01262	Cast Iron, Assumed	6"	5.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01271	Cast Iron, Assumed	6"	269.2	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01272	Cast Iron, Assumed	6"	643.7	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01273	Cast Iron, Assumed	6"	694.1	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01309	Cast Iron, Assumed	6"	395.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01316	Cast Iron, Assumed	6"	197.0	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01321	Cast Iron, Assumed	6"	19.5	2005	11	0.8	0	0.4	75	4.4	1.5	6.5	0.1	64
WMAIN-01352	Cast Iron, Assumed	6"	85.2	1909	108	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-01353	Cast Iron, Assumed	6"	181.9	1909	108	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-01354	Cast Iron, Assumed	6"	212.7	1950	67	0.2	0	0.4	75	2.6	8.9	23.2	0.9	8
WMAIN-01355	Cast Iron, Assumed	6"	24.5	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01358	Cast Iron, Assumed	6"	2007.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01360	Cast Iron, Assumed	6"	661.9	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-01362	Cast Iron, Assumed	6"	30.9	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01391	Cast Iron, Assumed	6"	52.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01393	Cast Iron, Assumed	6"	7.3	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01421	Cast Iron, Assumed	6"	3.8	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01422	Cast Iron, Assumed	6"	0.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01442	Cast Iron, Assumed	6"	2.2	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01450	Cast Iron, Assumed	6"	52.6	1937	80	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01452	Cast Iron, Assumed	6"	7.4	1934	83	0.2	0.5	0.4	75	3.6	10.0	36.0	1.0	0
WMAIN-01453	Cast Iron, Assumed	6"	5.2	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-01454	Cast Iron, Assumed	6"	45.9	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-01458	Cast Iron, Assumed	6"	21.3	1959	58	0.2	0	0.4	75	2.6	7.7	20.1	0.8	17
WMAIN-01470	Cast Iron, Assumed	6"	640.6	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-01471	Cast Iron, Assumed	6"	53.0	Pre-1951	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01477	Cast Iron, Assumed	6"	24.5	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-01478	Cast Iron, Assumed	6"	20.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01479	Cast Iron, Assumed	6"	24.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01480	Cast Iron, Assumed	6"	625.0	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01481	Cast Iron, Assumed	6"	623.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01482	Cast Iron, Assumed	6"	51.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01483	Cast Iron, Assumed	6"	55.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01484	Cast Iron, Assumed	6"	25.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01485	Cast Iron, Assumed	6"	39.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01486	Cast Iron, Assumed	6"	280.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01487	Cast Iron, Assumed	6"	49.6	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01488	Cast Iron, Assumed	6"	39.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01489	Cast Iron, Assumed	6"	190.6	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-01490	Cast Iron, Assumed	6"	38.3	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01492	Cast Iron, Assumed	6"	38.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01494	Cast Iron, Assumed	6"	99.8	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01495	Cast Iron, Assumed	6"	52.9	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01496	Cast Iron, Assumed	6"	48.3	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01497	Cast Iron, Assumed	6"	3.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01498	Cast Iron, Assumed	6"	51.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01501	Cast Iron, Assumed	6"	103.3	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01502	Cast Iron, Assumed	6"	266.7	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01504	Cast Iron, Assumed	6"	5.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01505	Cast Iron, Assumed	6"	4.2	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01506	Cast Iron, Assumed	6"	8.7	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01507	Cast Iron, Assumed	6"	27.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01508	Cast Iron, Assumed	6"	141.5	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-01509	Cast Iron, Assumed	6"	26.4	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-01510	Cast Iron, Assumed	6"	56.0	1959	58	0.3	0	0.4	75	2.9	7.7	22.4	0.8	17
WMAIN-01511	Cast Iron, Assumed	6"	56.0	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01512	Cast Iron, Assumed	6"	83.8	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01527	Cast Iron, Assumed	6"	113.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01540	Cast Iron, Assumed	6"	4.5	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01541	Cast Iron, Assumed	6"	4.5	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01548	Cast Iron, Assumed	6"	113.9	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01562	Cast Iron, Assumed	6"	49.6	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01624	Cast Iron, Assumed	6"	141.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01625	Cast Iron, Assumed	6"	117.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01627	Cast Iron, Assumed	6"	2.7	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01631	Cast Iron, Assumed	6"	0.2	1909	108	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01633	Cast Iron, Assumed	6"	2.2	1909	108	0.3	0	0.4	75	2.9	10.0	29.0	1.0	0
WMAIN-01634	Cast Iron, Assumed	6"	7.3	1909	108	0.3	0	0.4	75	2.9	10.0	29.0	1.0	0
WMAIN-01635	Cast Iron, Assumed	6"	11.9	1909	108	0.3	0	0.4	75	2.9	10.0	29.0	1.0	0
WMAIN-01636	Cast Iron, Assumed	6"	11.6	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01641	Cast Iron, Assumed	6"	4.9	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01642	Cast Iron, Assumed	6"	55.6	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01644	Cast Iron, Assumed	6"	31.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01645	Cast Iron, Assumed	6"	20.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01647	Cast Iron, Assumed	6"	3.4	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01648	Cast Iron, Assumed	6"	36.9	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01649	Cast Iron, Assumed	6"	4.6	1950	67	1	0	0.4	75	5	8.9	44.7	0.9	8
WMAIN-01650	Cast Iron, Assumed	6"	173.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01651	Cast Iron, Assumed	6"	77.4	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01652	Cast Iron, Assumed	6"	15.0	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01653	Cast Iron, Assumed	6"	36.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01659	Cast Iron, Assumed	6"	3.9	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01663	Cast Iron, Assumed	6"	37.0	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01666	Cast Iron, Assumed	6"	97.3	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01674	Cast Iron, Assumed	6"	7.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01675	Cast Iron, Assumed	6"	2.8	1950	67	0.8	0	0.4	75	4.4	8.9	39.3	0.9	8
WMAIN-01676	Cast Iron, Assumed	6"	20.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01678	Cast Iron, Assumed	6"	37.1	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01681	Cast Iron, Assumed	6"	36.5	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01683	Cast Iron, Assumed	6"	18.7	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01689	Cast Iron, Assumed	6"	572.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01690	Cast Iron, Assumed	6"	61.2	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01695	Cast Iron, Assumed	6"	20.0	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01698	Cast Iron, Assumed	6"	33.5	1909	108	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01704	Cast Iron, Assumed	6"	3.1	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-01705	Cast Iron, Assumed	6"	4.5	2005	11	0.8	0	0.4	75	4.4	1.5	6.5	0.1	64
WMAIN-01706	Cast Iron, Assumed	6"	3.9	1950	67	0.2	0	0.4	75	2.6	8.9	23.2	0.9	8
WMAIN-01714	Cast Iron, Assumed	6"	5.6	1934	83	0.2	0	0.4	75	2.6	10.0	26.0	1.0	0
WMAIN-01715	Cast Iron, Assumed	6"	45.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01716	Cast Iron, Assumed	6"	56.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0

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WMAIN-01717	Cast Iron, Assumed	6"	29.2	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01718	Cast Iron, Assumed	6"	315.9	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01719	Cast Iron, Assumed	6"	55.0	Pre-1947	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01720	Cast Iron, Assumed	6"	9.4	1934	83	0.8	0	0.4	75	4.4	10.0	44.0	1.0	0
WMAIN-01722	Cast Iron, Assumed	6"	18.5	1934	83	1	0	0.4	75	5	10.0	50.0	1.0	0
WMAIN-01732	Cast Iron, Assumed	6"	23.5	1959	58	1	0	0.4	75	5	7.7	38.7	0.8	17
WMAIN-01733	Cast Iron, Assumed	6"	11.9	1959	58	0.8	0	0.4	75	4.4	7.7	34.0	0.8	17
WMAIN-01736	Cast Iron, Assumed	6"	97.4	1951	66	0.8	0	0.4	75	4.4	8.8	38.7	0.9	9
<Null>	Ductile Iron	6"	7.1	2015	2	1	0	0.4	90	5	0.2	1.1	0.0	88
WMAIN-00629	Ductile Iron, Assumed	6"	9.0	2006	11	0.2	0	0.4	90	2.6	1.2	3.2	0.1	79
WMAIN-00652	Ductile Iron, Assumed	6"	37.7	1974	43	1	0	0.4	90	5	4.8	23.9	0.5	47
WMAIN-00653	Ductile Iron, Assumed	6"	32.2	1974	43	1	0	0.4	90	5	4.8	23.9	0.5	47
WMAIN-00655	Ductile Iron, Assumed	6"	10.0	1974	43	1	0	0.4	90	5	4.8	23.9	0.5	47
WMAIN-00656	Ductile Iron, Assumed	6"	8.0	1974	43	1	0	0.4	90	5	4.8	23.9	0.5	47
WMAIN-00742	Ductile Iron, Assumed	6"	51.1	2008	9	1	0	0.4	90	5	1.0	5.0	0.1	81
WMAIN-00761	Ductile Iron, Assumed	6"	47.0	1971	46	0	0	0.4	90	2	5.1	10.2	0.5	44
WMAIN-00762	Ductile Iron, Assumed	6"	45.0	1971	46	0.8	0	0.4	90	4.4	5.1	22.5	0.5	44
WMAIN-00779	Ductile Iron, Assumed	6"	116.1	1974	43	0.8	0	0.4	90	4.4	4.8	21.0	0.5	47
WMAIN-00793	Ductile Iron, Assumed	6"	6.6	1974	43	0	0	0.4	90	2	4.8	9.6	0.5	47
WMAIN-01003	Ductile Iron, Assumed	6"	102.5	1974	43	1	0	0.4	90	5	4.8	23.9	0.5	47
WMAIN-01004	Ductile Iron, Assumed	6"	253.5	1974	43	0	0	0.4	90	2	4.8	9.6	0.5	47
WMAIN-01040	Ductile Iron, Assumed	6"	102.6	1974	43	0.2	0.8	0.4	90	4.2	4.8	20.1	0.5	47
WMAIN-01041	Ductile Iron, Assumed	6"	306.1	1974	43	0.2	0.8	0.4	90	4.2	4.8	20.1	0.5	47
WMAIN-01042	Ductile Iron, Assumed	6"	47.3	1974	43	0.2	0	0.4	90	2.6	4.8	12.4	0.5	47
WMAIN-01043	Ductile Iron, Assumed	6"	214.0	2007	10	1	0.8	0.4	90	6.6	1.1	7.3	0.1	80
WMAIN-01162	Ductile Iron, Assumed	6"	235.5	2008	8	1	0	0.4	90	5	0.9	4.4	0.1	82
WMAIN-01213	Ductile Iron, Assumed	6"	7.6	2007	10	0.3	0	0.4	90	2.9	1.1	3.2	0.1	80
WMAIN-01252	Ductile Iron, Assumed	6"	120.0	2008	8	1	0	0.4	90	5	0.9	4.4	0.1	82
WMAIN-01525	Ductile Iron, Assumed	6"	248.0	2007	10	1	0	0.4	90	5	1.1	5.6	0.1	80
WMAIN-01542	Ductile Iron, Assumed	6"	14.0	2008	9	1	0	0.4	90	5	1.0	5.0	0.1	81
WMAIN-01543	Ductile Iron, Assumed	6"	11.2	2008	8	1	0	0.4	90	5	0.9	4.4	0.1	82
WMAIN-01670	Ductile Iron, Assumed	6"	9.7	1974	43	1	0	0.4	90	5	4.8	23.9	0.5	47
WMAIN-01697	Ductile Iron, Assumed	6"	3.3	1974	43	0	0	0.4	90	2	4.8	9.6	0.5	47
WMAIN-00004	Cast Iron, Assumed	8"	330.1	1934	83	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-00017	Cast Iron, Assumed	8"	662.5	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-00048	Cast Iron, Assumed	8"	22.6	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00049	Cast Iron, Assumed	8"	3.0	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00072	Cast Iron, Assumed	8"	357.9	1909	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-00073	Cast Iron, Assumed	8"	436.4	1940	77	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00074	Cast Iron, Assumed	8"	349.1	1940	77	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00079	Cast Iron, Assumed	8"	261.3	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-00081	Cast Iron, Assumed	8"	69.4	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-00082	Cast Iron, Assumed	8"	13.3	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-00086	Cast Iron, Assumed	8"	279.8	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-00087	Cast Iron, Assumed	8"	353.8	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00149	Cast Iron, Assumed	8"	187.5	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00156	Cast Iron, Assumed	8"	713.1	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00160	Cast Iron, Assumed	8"	7.9	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00172	Cast Iron, Assumed	8"	281.7	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00210	Cast Iron, Assumed	8"	3.3	1909	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-00236	Cast Iron, Assumed	8"	291.6	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00237	Cast Iron, Assumed	8"	301.6	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00238	Cast Iron, Assumed	8"	7.1	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00242	Cast Iron, Assumed	8"	36.6	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00243	Cast Iron, Assumed	8"	8.2	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00244	Cast Iron, Assumed	8"	36.7	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00245	Cast Iron, Assumed	8"	22.0	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00257	Cast Iron, Assumed	8"	925.8	1909	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-00281	Cast Iron, Assumed	8"	551.1	1909	108	1	0.8	0.7	75	8.1	10.0	81.0	1.0	0
WMAIN-00319	Cast Iron, Assumed	8"	305.4	Pre-1947	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00324	Cast Iron, Assumed	8"	674.2	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17

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WMAIN-00326	Cast Iron, Assumed	8"	197.2	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-00357	Cast Iron, Assumed	8"	664.2	2000	17	1	0	0.7	75	6.5	2.3	14.7	0.2	58
WMAIN-00358	Cast Iron, Assumed	8"	305.2	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00359	Cast Iron, Assumed	8"	289.7	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00383	Cast Iron, Assumed	8"	688.1	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-00384	Cast Iron, Assumed	8"	12.8	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-00419	Cast Iron, Assumed	8"	333.2	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-00453	Cast Iron, Assumed	8"	56.0	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00463	Cast Iron, Assumed	8"	363.3	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-00479	Cast Iron, Assumed	8"	9.4	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-00488	Cast Iron, Assumed	8"	325.5	Pre-1956	83	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-00489	Cast Iron, Assumed	8"	6.0	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-00497	Cast Iron, Assumed	8"	567.8	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00504	Cast Iron, Assumed	8"	27.7	1967	50	1	0	0.7	75	6.5	6.7	43.3	0.7	25
WMAIN-00506	Cast Iron, Assumed	8"	27.0	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00507	Cast Iron, Assumed	8"	3.6	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00517	Cast Iron, Assumed	8"	88.7	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00518	Cast Iron, Assumed	8"	4.2	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00569	Cast Iron, Assumed	8"	214.0	1934	83	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-00585	Cast Iron, Assumed	8"	334.3	Pre-1956	83	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-00592	Cast Iron, Assumed	8"	35.0	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00593	Cast Iron, Assumed	8"	352.9	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00596	Cast Iron, Assumed	8"	18.4	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00605	Cast Iron, Assumed	8"	22.2	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00607	Cast Iron, Assumed	8"	262.1	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00608	Cast Iron, Assumed	8"	5.6	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00670	Cast Iron, Assumed	8"	292.6	Pre-1947	83	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-00671	Cast Iron, Assumed	8"	640.2	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-00695	Cast Iron, Assumed	8"	627.5	1934	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00702	Cast Iron, Assumed	8"	578.2	1909	108	1	0.5	0.7	75	7.5	10.0	75.0	1.0	0
WMAIN-00769	Cast Iron, Assumed	8"	649.8	1959	58	1	0.8	0.7	75	8.1	7.7	62.6	0.8	17
WMAIN-00771	Cast Iron, Assumed	8"	355.0	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-00772	Cast Iron, Assumed	8"	33.1	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-00773	Cast Iron, Assumed	8"	38.3	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-00774	Cast Iron, Assumed	8"	193.0	1959	58	1	0.8	0.7	75	8.1	7.7	62.6	0.8	17
WMAIN-00804	Cast Iron, Assumed	8"	47.7	1937	80	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00805	Cast Iron, Assumed	8"	298.6	1937	80	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00829	Cast Iron, Assumed	8"	743.6	1940	77	0.2	0.8	0.7	75	5.7	10.0	57.0	1.0	0
WMAIN-00846	Cast Iron, Assumed	8"	201.2	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01001	Cast Iron, Assumed	8"	541.3	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-01010	Cast Iron, Assumed	8"	159.5	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01025	Cast Iron, Assumed	8"	207.0	1934	83	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01026	Cast Iron, Assumed	8"	128.7	1934	83	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01027	Cast Iron, Assumed	8"	96.7	1950	67	0.8	0	0.7	75	5.9	8.9	52.7	0.9	8
WMAIN-01036	Cast Iron, Assumed	8"	1051.4	1950	67	0.2	0	0.7	75	4.1	8.9	36.6	0.9	8
WMAIN-01074	Cast Iron, Assumed	8"	7.4	1959	58	0.2	0	0.7	75	4.1	7.7	31.7	0.8	17
WMAIN-01075	Cast Iron, Assumed	8"	80.4	1959	58	0.2	0	0.7	75	4.1	7.7	31.7	0.8	17
WMAIN-01076	Cast Iron, Assumed	8"	260.2	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-01115	Cast Iron, Assumed	8"	238.7	1947	70	1	0.5	0.7	75	7.5	9.3	70.0	0.9	5
WMAIN-01132	Cast Iron, Assumed	8"	63.4	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01136	Cast Iron, Assumed	8"	60.8	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01137	Cast Iron, Assumed	8"	92.3	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01138	Cast Iron, Assumed	8"	81.1	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01139	Cast Iron, Assumed	8"	108.6	1909	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01140	Cast Iron, Assumed	8"	59.6	1909	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01141	Cast Iron, Assumed	8"	143.9	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01145	Cast Iron, Assumed	8"	5.5	1937	80	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01146	Cast Iron, Assumed	8"	6.9	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01160	Cast Iron, Assumed	8"	83.1	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01170	Cast Iron, Assumed	8"	97.1	2008	9	1	0	0.7	75	6.5	1.2	7.8	0.1	66
WMAIN-01257	Cast Iron, Assumed	8"	10.1	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-01258	Cast Iron, Assumed	8"	4.3	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-01259	Cast Iron, Assumed	8"	61.6	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-01266	Cast Iron, Assumed	8"	7.5	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01267	Cast Iron, Assumed	8"	2.9	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01268	Cast Iron, Assumed	8"	6.0	1909	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01269	Cast Iron, Assumed	8"	19.1	1909	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01310	Cast Iron, Assumed	8"	214.5	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01311	Cast Iron, Assumed	8"	14.4	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01317	Cast Iron, Assumed	8"	312.7	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01319	Cast Iron, Assumed	8"	148.5	1947	70	0.8	0.5	0.7	75	6.9	9.3	64.4	0.9	5
WMAIN-01320	Cast Iron, Assumed	8"	88.0	1947	70	0.8	1	0.7	75	7.9	9.3	73.7	0.9	5
WMAIN-01322	Cast Iron, Assumed	8"	793.2	2005	11	0.8	0	0.7	75	5.9	1.5	8.7	0.1	64
WMAIN-01323	Cast Iron, Assumed	8"	1179.3	2005	11	0.8	0	0.7	75	5.9	1.5	8.7	0.1	64
WMAIN-01330	Cast Iron, Assumed	8"	7.5	1909	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01339	Cast Iron, Assumed	8"	296.4	Pre-2006	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01340	Cast Iron, Assumed	8"	360.9	1909	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01367	Cast Iron, Assumed	8"	0.0	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-01377	Cast Iron, Assumed	8"	18.9	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-01378	Cast Iron, Assumed	8"	24.8	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01389	Cast Iron, Assumed	8"	16.3	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01427	Cast Iron, Assumed	8"	0.0	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01440	Cast Iron, Assumed	8"	111.8	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-01441	Cast Iron, Assumed	8"	10.0	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-01443	Cast Iron, Assumed	8"	9.1	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-01444	Cast Iron, Assumed	8"	58.1	1940	77	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01445	Cast Iron, Assumed	8"	70.1	1940	77	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01446	Cast Iron, Assumed	8"	661.3	1940	77	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01468	Cast Iron, Assumed	8"	72.1	Pre-1956	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01469	Cast Iron, Assumed	8"	293.8	Pre-1956	83	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01472	Cast Iron, Assumed	8"	43.2	Pre-1947	83	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01473	Cast Iron, Assumed	8"	25.0	Pre-1947	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01499	Cast Iron, Assumed	8"	25.0	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01500	Cast Iron, Assumed	8"	7.7	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01518	Cast Iron, Assumed	8"	55.4	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01520	Cast Iron, Assumed	8"	90.1	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01547	Cast Iron, Assumed	8"	23.5	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-01617	Cast Iron, Assumed	8"	18.7	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01619	Cast Iron, Assumed	8"	3.3	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01661	Cast Iron, Assumed	8"	5.4	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01671	Cast Iron, Assumed	8"	43.5	1909	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01725	Cast Iron, Assumed	8"	284.8	Pre-1947	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01729	Cast Iron, Assumed	8"	5.6	Pre-1947	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01731	Cast Iron, Assumed	8"	30.9	Pre-1947	83	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00357	Cast Iron, Assumed	8"	332.0	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01356	Ductile Iron	8"	13.0	2008	9	0.8	0	0.7	90	5.9	1.0	5.9	0.1	81
WMAIN-01357	Ductile Iron	8"	636.1	2008	9	0.8	0	0.7	90	5.9	1.0	5.9	0.1	81
WMAIN-01739	Ductile Iron	8"	20.8	2008	9	0.8	0	0.7	90	5.9	1.0	5.9	0.1	81
WMAIN-01740	Ductile Iron	8"	12.4	2008	9	0.8	0	0.7	90	5.9	1.0	5.9	0.1	81
WMAIN-01741	Ductile Iron	8"	805.1	2008	9	0.8	0	0.7	90	5.9	1.0	5.9	0.1	81
WMAIN-01744	Ductile Iron	8"	732.5	2008	9	0.8	0	0.7	90	5.9	1.0	5.9	0.1	81
WMAIN-01746	Ductile Iron	8"	689.9	2008	9	0.8	0	0.7	90	5.9	1.0	5.9	0.1	81
WMAIN-01747	Ductile Iron	8"	629.4	2008	9	0.8	0	0.7	90	5.9	1.0	5.9	0.1	81
<Null>	Ductile Iron	8"	8.8	2015	2	0.8	0	0.7	90	5.9	0.2	1.3	0.0	88
<Null>	Ductile Iron	8"	29.9	2015	2	0.8	0	0.7	90	5.9	0.2	1.3	0.0	88
<Null>	Ductile Iron	8"	289.6	2015	2	0.8	0	0.7	90	5.9	0.2	1.3	0.0	88
<Null>	Ductile Iron	8"	116.5	2015	2	1	0	0.7	90	6.5	0.2	1.4	0.0	88
<Null>	Ductile Iron	8"	75.5	2015	2	0.8	0	0.7	90	5.9	0.2	1.3	0.0	88
<Null>	Ductile Iron	8"	399.5	2015	2	0.8	0	0.7	90	5.9	0.2	1.3	0.0	88
<Null>	Ductile Iron	8"	487.0	2015	2	1	0	0.7	90	6.5	0.2	1.4	0.0	88
WMAIN-00167	Ductile Iron, Assumed	8"	212.0	1974	43	1	0	0.7	90	6.5	4.8	31.1	0.5	47
WMAIN-00212	Ductile Iron, Assumed	8"	15.5	2006	11	1	0	0.7	90	6.5	1.2	7.9	0.1	79

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00651	Ductile Iron, Assumed	8"	196.3	1974	43	1	0	0.7	90	6.5	4.8	31.1	0.5	47
WMAIN-00785	Ductile Iron, Assumed	8"	16.0	1993	24	1	0	0.7	90	6.5	2.7	17.3	0.3	66
WMAIN-00787	Ductile Iron, Assumed	8"	24.0	1993	24	1	0	0.7	90	6.5	2.7	17.3	0.3	66
WMAIN-00813	Ductile Iron, Assumed	8"	265.7	2007	10	0.8	0	0.7	90	5.9	1.1	6.6	0.1	80
WMAIN-00814	Ductile Iron, Assumed	8"	427.6	2007	10	0.8	0	0.7	90	5.9	1.1	6.6	0.1	80
WMAIN-00815	Ductile Iron, Assumed	8"	216.8	2007	10	0.8	0	0.7	90	5.9	1.1	6.6	0.1	80
WMAIN-00816	Ductile Iron, Assumed	8"	12.5	2007	10	0.8	0	0.7	90	5.9	1.1	6.6	0.1	80
WMAIN-00817	Ductile Iron, Assumed	8"	94.3	2007	10	0.2	0	0.7	90	4.1	1.1	4.6	0.1	80
WMAIN-00833	Ductile Iron, Assumed	8"	1176.9	1974	43	1	0	0.7	90	6.5	4.8	31.1	0.5	47
WMAIN-00860	Ductile Iron, Assumed	8"	5.0	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-00887	Ductile Iron, Assumed	8"	6.5	2002	15	0.3	0	0.7	90	4.4	1.7	7.3	0.2	75
WMAIN-00891	Ductile Iron, Assumed	8"	70.3	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01091	Ductile Iron, Assumed	8"	481.1	1974	43	1	0	0.7	90	6.5	4.8	31.1	0.5	47
WMAIN-01107	Ductile Iron, Assumed	8"	17.7	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01215	Ductile Iron, Assumed	8"	324.8	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01216	Ductile Iron, Assumed	8"	38.9	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01217	Ductile Iron, Assumed	8"	18.0	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01218	Ductile Iron, Assumed	8"	19.0	2007	10	1	0.5	0.7	90	7.5	1.1	8.3	0.1	80
WMAIN-01219	Ductile Iron, Assumed	8"	3.4	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01220	Ductile Iron, Assumed	8"	32.2	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01221	Ductile Iron, Assumed	8"	32.3	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01222	Ductile Iron, Assumed	8"	338.3	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01223	Ductile Iron, Assumed	8"	141.5	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01224	Ductile Iron, Assumed	8"	284.6	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01225	Ductile Iron, Assumed	8"	231.6	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01226	Ductile Iron, Assumed	8"	76.8	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01227	Ductile Iron, Assumed	8"	34.3	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01228	Ductile Iron, Assumed	8"	17.9	2007	10	1	0.5	0.7	90	7.5	1.1	8.3	0.1	80
WMAIN-01229	Ductile Iron, Assumed	8"	7.0	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01230	Ductile Iron, Assumed	8"	9.6	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01231	Ductile Iron, Assumed	8"	119.2	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01232	Ductile Iron, Assumed	8"	89.0	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01233	Ductile Iron, Assumed	8"	89.0	2007	10	1	0.5	0.7	90	7.5	1.1	8.3	0.1	80
WMAIN-01234	Ductile Iron, Assumed	8"	15.7	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01235	Ductile Iron, Assumed	8"	59.7	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01236	Ductile Iron, Assumed	8"	93.1	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01237	Ductile Iron, Assumed	8"	131.9	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01238	Ductile Iron, Assumed	8"	10.6	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01239	Ductile Iron, Assumed	8"	30.0	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01240	Ductile Iron, Assumed	8"	16.9	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01241	Ductile Iron, Assumed	8"	15.0	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01242	Ductile Iron, Assumed	8"	22.4	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01243	Ductile Iron, Assumed	8"	249.9	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01244	Ductile Iron, Assumed	8"	52.6	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01245	Ductile Iron, Assumed	8"	11.6	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01246	Ductile Iron, Assumed	8"	50.5	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01270	Ductile Iron, Assumed	8"	107.3	2007	10	0.2	0	0.7	90	4.1	1.1	4.6	0.1	80
WMAIN-01274	Ductile Iron, Assumed	8"	9.7	2007	10	0.8	0	0.7	90	5.9	1.1	6.6	0.1	80
WMAIN-01275	Ductile Iron, Assumed	8"	75.1	2009	8	0.2	0.8	0.7	90	5.7	0.9	5.1	0.1	82
WMAIN-01276	Ductile Iron, Assumed	8"	244.5	2009	8	0.8	0.5	0.7	90	6.9	0.9	6.1	0.1	82
WMAIN-01277	Ductile Iron, Assumed	8"	60.5	2009	8	0.8	0	0.7	90	5.9	0.9	5.2	0.1	82
WMAIN-01278	Ductile Iron, Assumed	8"	191.3	2009	8	0.8	0	0.7	90	5.9	0.9	5.2	0.1	82
WMAIN-01279	Ductile Iron, Assumed	8"	257.6	2009	8	0.8	0	0.7	90	5.9	0.9	5.2	0.1	82
WMAIN-01280	Ductile Iron, Assumed	8"	54.2	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01281	Ductile Iron, Assumed	8"	100.7	2009	8	0.2	0.5	0.7	90	5.1	0.9	4.5	0.1	82
WMAIN-01282	Ductile Iron, Assumed	8"	28.8	2009	8	0.2	0.8	0.7	90	5.7	0.9	5.1	0.1	82
WMAIN-01283	Ductile Iron, Assumed	8"	23.8	2009	8	0.2	0.8	0.7	90	5.7	0.9	5.1	0.1	82
WMAIN-01284	Ductile Iron, Assumed	8"	90.0	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01285	Ductile Iron, Assumed	8"	75.8	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01286	Ductile Iron, Assumed	8"	56.0	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01287	Ductile Iron, Assumed	8"	36.5	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-01288	Ductile Iron, Assumed	8"	539.5	2009	8	0.8	0	0.7	90	5.9	0.9	5.2	0.1	82
WMAIN-01289	Ductile Iron, Assumed	8"	21.6	2009	8	0.8	0	0.7	90	5.9	0.9	5.2	0.1	82
WMAIN-01290	Ductile Iron, Assumed	8"	29.9	2009	8	0.2	0.5	0.7	90	5.1	0.9	4.5	0.1	82
WMAIN-01291	Ductile Iron, Assumed	8"	32.7	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01292	Ductile Iron, Assumed	8"	14.6	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01293	Ductile Iron, Assumed	8"	18.0	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01294	Ductile Iron, Assumed	8"	8.0	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01295	Ductile Iron, Assumed	8"	8.4	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01296	Ductile Iron, Assumed	8"	22.5	2009	8	0.2	0.5	0.7	90	5.1	0.9	4.5	0.1	82
WMAIN-01297	Ductile Iron, Assumed	8"	16.5	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01298	Ductile Iron, Assumed	8"	0.4	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01299	Ductile Iron, Assumed	8"	104.4	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01308	Ductile Iron, Assumed	8"	1273.1	2007	10	0.2	0	0.7	90	4.1	1.1	4.6	0.1	80
WMAIN-01312	Ductile Iron, Assumed	8"	19.4	2008	8	1	0	0.7	90	6.5	0.9	5.8	0.1	82
WMAIN-01331	Ductile Iron, Assumed	8"	697.2	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01332	Ductile Iron, Assumed	8"	650.1	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01333	Ductile Iron, Assumed	8"	195.8	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01334	Ductile Iron, Assumed	8"	236.9	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01335	Ductile Iron, Assumed	8"	30.3	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01336	Ductile Iron, Assumed	8"	28.9	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01337	Ductile Iron, Assumed	8"	14.0	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01338	Ductile Iron, Assumed	8"	228.8	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01341	Ductile Iron, Assumed	8"	362.5	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01342	Ductile Iron, Assumed	8"	134.9	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01343	Ductile Iron, Assumed	8"	14.9	2006	11	1	0	0.7	90	6.5	1.2	7.9	0.1	79
WMAIN-01344	Ductile Iron, Assumed	8"	12.0	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01345	Ductile Iron, Assumed	8"	5.6	2006	11	0.8	0	0.7	90	5.9	1.2	7.2	0.1	79
WMAIN-01346	Ductile Iron, Assumed	8"	9.3	2006	11	1	0	0.7	90	6.5	1.2	7.9	0.1	79
WMAIN-01347	Ductile Iron, Assumed	8"	32.8	2015	2	0.8	0	0.7	90	5.9	0.2	1.3	0.0	88
WMAIN-01359	Ductile Iron, Assumed	8"	96.1	1974	43	0.2	0	0.7	90	4.1	4.8	19.6	0.5	47
WMAIN-01375	Ductile Iron, Assumed	8"	78.6	2007	10	0.2	0	0.7	90	4.1	1.1	4.6	0.1	80
WMAIN-01376	Ductile Iron, Assumed	8"	0.1	2007	10	0.2	0	0.7	90	4.1	1.1	4.6	0.1	80
WMAIN-01522	Ductile Iron, Assumed	8"	55.5	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01523	Ductile Iron, Assumed	8"	78.1	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01524	Ductile Iron, Assumed	8"	9.9	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01528	Ductile Iron, Assumed	8"	98.4	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01529	Ductile Iron, Assumed	8"	27.0	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01530	Ductile Iron, Assumed	8"	11.0	2007	10	0.3	0	0.7	90	4.4	1.1	4.9	0.1	80
WMAIN-01626	Ductile Iron, Assumed	8"	4.3	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01707	Ductile Iron, Assumed	8"	3.3	2007	10	1	0	0.7	90	6.5	1.1	7.2	0.1	80
WMAIN-01708	Ductile Iron, Assumed	8"	31.6	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01709	Ductile Iron, Assumed	8"	6.3	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01710	Ductile Iron, Assumed	8"	0.8	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01711	Ductile Iron, Assumed	8"	0.8	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
WMAIN-01712	Ductile Iron, Assumed	8"	9.8	2009	8	0.2	0	0.7	90	4.1	0.9	3.6	0.1	82
<Null>	Ductile Iron, Assumed	8"	13.6	2015	2	0.8	0	0.7	90	5.9	0.2	1.3	0.0	88
WMAIN-00084	Cast Iron, Assumed	10"	574.8	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-00096	Cast Iron, Assumed	10"	291.3	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00097	Cast Iron, Assumed	10"	308.0	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00098	Cast Iron, Assumed	10"	325.3	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00099	Cast Iron, Assumed	10"	369.8	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00100	Cast Iron, Assumed	10"	291.0	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00606	Cast Iron, Assumed	10"	598.1	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00615	Cast Iron, Assumed	10"	90.7	1969	48	1	0	0.7	75	6.5	6.4	41.6	0.6	27
WMAIN-00758	Cast Iron, Assumed	10"	71.5	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00795	Cast Iron, Assumed	10"	144.6	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00796	Cast Iron, Assumed	10"	129.5	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00797	Cast Iron, Assumed	10"	116.7	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00798	Cast Iron, Assumed	10"	121.0	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-00811	Cast Iron, Assumed	10"	10.5	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-00830	Cast Iron, Assumed	10"	381.5	1959	58	0.2	0	0.7	75	4.1	7.7	31.7	0.8	17

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00831	Cast Iron, Assumed	10"	313.9	1959	58	0.2	0.5	0.7	75	5.1	7.7	39.4	0.8	17
WMAIN-00923	Cast Iron, Assumed	10"	434.4	1959	58	0.2	1	0.7	75	6.1	7.7	47.2	0.8	17
WMAIN-00954	Cast Iron, Assumed	10"	260.1	1959	58	0.8	0	0.7	75	5.9	7.7	45.6	0.8	17
WMAIN-00955	Cast Iron, Assumed	10"	419.4	1959	58	0.8	0	0.7	75	5.9	7.7	45.6	0.8	17
WMAIN-01082	Cast Iron, Assumed	10"	52.2	1959	58	0.2	0	0.7	75	4.1	7.7	31.7	0.8	17
WMAIN-01129	Cast Iron, Assumed	10"	96.1	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-01166	Cast Iron, Assumed	10"	17.0	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01256	Cast Iron, Assumed	10"	429.9	1950	67	1	0	0.7	75	6.5	8.9	58.1	0.9	8
WMAIN-01314	Cast Iron, Assumed	10"	638.6	1909	108	0.8	0	0.7	75	5.9	10.0	59.0	1.0	0
WMAIN-01451	Cast Iron, Assumed	10"	38.4	1959	58	1	0	0.7	75	6.5	7.7	50.3	0.8	17
WMAIN-01699	Cast Iron, Assumed	10"	20.2	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01700	Cast Iron, Assumed	10"	74.9	1909	108	1	0	0.7	75	6.5	10.0	65.0	1.0	0
WMAIN-01713	Cast Iron, Assumed	10"	3.3	1959	58	0.8	0	0.7	75	5.9	7.7	45.6	0.8	17
WMAIN-00825	Ductile Iron, Assumed	10"	11.1	2008	8	1	0	0.7	90	6.5	0.9	5.8	0.1	82
WMAIN-01104	Ductile Iron, Assumed	10"	8.0	1974	43	0.2	0	0.7	90	4.1	4.8	19.6	0.5	47
WMAIN-01133	Ductile Iron, Assumed	10"	64.6	2008	8	1	0	0.7	90	6.5	0.9	5.8	0.1	82
WMAIN-01428	Ductile Iron, Assumed	10"	1.5	2008	8	1	0	0.7	90	6.5	0.9	5.8	0.1	82
WMAIN-01503	Ductile Iron, Assumed	10"	257.0	1974	43	0.2	0	0.7	90	4.1	4.8	19.6	0.5	47
WMAIN-00014	Cast Iron, Assumed	12"	8.0	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00015	Cast Iron, Assumed	12"	15.0	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00043	Cast Iron, Assumed	12"	172.7	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00044	Cast Iron, Assumed	12"	185.4	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00062	Cast Iron, Assumed	12"	8.0	1934	83	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00063	Cast Iron, Assumed	12"	317.9	1967	50	0.8	0	1	75	7.4	6.7	49.3	0.7	25
WMAIN-00064	Cast Iron, Assumed	12"	7.0	1934	83	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00065	Cast Iron, Assumed	12"	300.3	1967	50	0.8	0	1	75	7.4	6.7	49.3	0.7	25
WMAIN-00066	Cast Iron, Assumed	12"	9.4	1967	50	0.8	0	1	75	7.4	6.7	49.3	0.7	25
WMAIN-00077	Cast Iron, Assumed	12"	636.8	1959	58	0.3	0	1	75	5.9	7.7	45.6	0.8	17
WMAIN-00080	Cast Iron, Assumed	12"	9.4	1940	77	0	0	1	75	5	10.0	50.0	1.0	0
WMAIN-00088	Cast Iron, Assumed	12"	295.6	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00089	Cast Iron, Assumed	12"	286.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00091	Cast Iron, Assumed	12"	9.4	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00095	Cast Iron, Assumed	12"	44.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00116	Cast Iron, Assumed	12"	22.6	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00117	Cast Iron, Assumed	12"	16.1	1937	80	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00125	Cast Iron, Assumed	12"	397.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00126	Cast Iron, Assumed	12"	363.6	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00127	Cast Iron, Assumed	12"	316.0	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00128	Cast Iron, Assumed	12"	272.2	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00130	Cast Iron, Assumed	12"	9.4	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00132	Cast Iron, Assumed	12"	275.9	1937	80	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00133	Cast Iron, Assumed	12"	231.2	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00134	Cast Iron, Assumed	12"	315.1	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00173	Cast Iron, Assumed	12"	502.1	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00174	Cast Iron, Assumed	12"	324.9	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00177	Cast Iron, Assumed	12"	22.8	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00178	Cast Iron, Assumed	12"	73.5	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00181	Cast Iron, Assumed	12"	12.3	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00195	Cast Iron, Assumed	12"	312.4	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00196	Cast Iron, Assumed	12"	325.6	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00201	Cast Iron, Assumed	12"	342.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00214	Cast Iron, Assumed	12"	58.3	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00215	Cast Iron, Assumed	12"	225.4	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00216	Cast Iron, Assumed	12"	6.6	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00217	Cast Iron, Assumed	12"	5.8	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00220	Cast Iron, Assumed	12"	300.0	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00226	Cast Iron, Assumed	12"	360.8	1934	83	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00227	Cast Iron, Assumed	12"	25.3	1934	83	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00260	Cast Iron, Assumed	12"	74.5	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00261	Cast Iron, Assumed	12"	792.6	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00262	Cast Iron, Assumed	12"	1028.2	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00325	Cast Iron, Assumed	12"	8.9	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00327	Cast Iron, Assumed	12"	630.5	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00328	Cast Iron, Assumed	12"	290.2	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00329	Cast Iron, Assumed	12"	631.4	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00330	Cast Iron, Assumed	12"	29.7	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00331	Cast Iron, Assumed	12"	14.7	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00360	Cast Iron, Assumed	12"	670.2	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00385	Cast Iron, Assumed	12"	1223.5	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00386	Cast Iron, Assumed	12"	9.5	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00388	Cast Iron, Assumed	12"	9.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00391	Cast Iron, Assumed	12"	9.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00415	Cast Iron, Assumed	12"	277.1	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00416	Cast Iron, Assumed	12"	116.4	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00418	Cast Iron, Assumed	12"	348.0	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00420	Cast Iron, Assumed	12"	22.1	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00421	Cast Iron, Assumed	12"	25.5	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00423	Cast Iron, Assumed	12"	9.4	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00426	Cast Iron, Assumed	12"	9.4	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00428	Cast Iron, Assumed	12"	291.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00429	Cast Iron, Assumed	12"	296.7	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00431	Cast Iron, Assumed	12"	333.8	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00432	Cast Iron, Assumed	12"	725.6	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00438	Cast Iron, Assumed	12"	17.3	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00449	Cast Iron, Assumed	12"	9.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00451	Cast Iron, Assumed	12"	9.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00458	Cast Iron, Assumed	12"	15.6	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00459	Cast Iron, Assumed	12"	36.2	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00460	Cast Iron, Assumed	12"	15.1	1967	50	0.8	0	1	75	7.4	6.7	49.3	0.7	25
WMAIN-00461	Cast Iron, Assumed	12"	9.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00465	Cast Iron, Assumed	12"	10.3	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00466	Cast Iron, Assumed	12"	0.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00467	Cast Iron, Assumed	12"	9.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00468	Cast Iron, Assumed	12"	3.9	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00469	Cast Iron, Assumed	12"	676.3	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00470	Cast Iron, Assumed	12"	61.9	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00471	Cast Iron, Assumed	12"	9.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00472	Cast Iron, Assumed	12"	9.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00473	Cast Iron, Assumed	12"	9.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00476	Cast Iron, Assumed	12"	9.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00481	Cast Iron, Assumed	12"	657.9	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00483	Cast Iron, Assumed	12"	222.7	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00491	Cast Iron, Assumed	12"	674.3	1967	50	0.2	0	1	75	5.6	6.7	37.3	0.7	25
WMAIN-00528	Cast Iron, Assumed	12"	40.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00529	Cast Iron, Assumed	12"	18.7	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00612	Cast Iron, Assumed	12"	80.2	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00613	Cast Iron, Assumed	12"	181.2	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00614	Cast Iron, Assumed	12"	126.7	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00625	Cast Iron, Assumed	12"	22.1	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00628	Cast Iron, Assumed	12"	13.7	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00639	Cast Iron, Assumed	12"	243.1	1937	80	0.2	1	1	75	7.6	10.0	76.0	1.0	0
WMAIN-00640	Cast Iron, Assumed	12"	300.8	1937	80	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00646	Cast Iron, Assumed	12"	58.4	1937	80	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00649	Cast Iron, Assumed	12"	505.8	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00679	Cast Iron, Assumed	12"	5.5	1967	50	0.8	0	1	75	7.4	6.7	49.3	0.7	25
WMAIN-00700	Cast Iron, Assumed	12"	473.9	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-00701	Cast Iron, Assumed	12"	180.2	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00726	Cast Iron, Assumed	12"	270.1	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00750	Cast Iron, Assumed	12"	31.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00751	Cast Iron, Assumed	12"	47.2	1909	108	0	0	1	75	5	10.0	50.0	1.0	0
WMAIN-00809	Cast Iron, Assumed	12"	60.9	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-00819	Cast Iron, Assumed	12"	177.6	1909	108	1	0	1	75	8	10.0	80.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00820	Cast Iron, Assumed	12"	35.4	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00821	Cast Iron, Assumed	12"	64.0	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00822	Cast Iron, Assumed	12"	41.6	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00823	Cast Iron, Assumed	12"	292.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00824	Cast Iron, Assumed	12"	91.4	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00826	Cast Iron, Assumed	12"	16.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00827	Cast Iron, Assumed	12"	90.9	1998	19	1	0	1	75	8	2.5	20.3	0.3	56
WMAIN-00837	Cast Iron, Assumed	12"	24.0	1947	70	0.2	0	1	75	5.6	9.3	52.3	0.9	5
WMAIN-00841	Cast Iron, Assumed	12"	305.2	2005	11	0.8	0	1	75	7.4	1.5	10.9	0.1	64
WMAIN-00843	Cast Iron, Assumed	12"	112.8	1947	70	1	0	1	75	8	9.3	74.7	0.9	5
WMAIN-00847	Cast Iron, Assumed	12"	347.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00848	Cast Iron, Assumed	12"	63.4	1969	48	1	0	1	75	8	6.4	51.2	0.6	27
WMAIN-00886	Cast Iron, Assumed	12"	71.4	2002	15	1	0	1	75	8	2.0	16.0	0.2	60
WMAIN-00896	Cast Iron, Assumed	12"	200.3	2002	15	1	0	1	75	8	2.0	16.0	0.2	60
WMAIN-00897	Cast Iron, Assumed	12"	111.6	2002	15	1	0	1	75	8	2.0	16.0	0.2	60
WMAIN-00901	Cast Iron, Assumed	12"	697.7	1959	58	0.2	0	1	75	5.6	7.7	43.3	0.8	17
WMAIN-00902	Cast Iron, Assumed	12"	150.6	1969	48	0.2	0	1	75	5.6	6.4	35.8	0.6	27
WMAIN-00903	Cast Iron, Assumed	12"	79.6	1969	48	0.2	0	1	75	5.6	6.4	35.8	0.6	27
WMAIN-00907	Cast Iron, Assumed	12"	838.5	1969	48	1	0	1	75	8	6.4	51.2	0.6	27
WMAIN-00908	Cast Iron, Assumed	12"	23.3	1909	108	0.3	0	1	75	5.9	10.0	59.0	1.0	0
WMAIN-00909	Cast Iron, Assumed	12"	47.8	1909	108	0.3	0	1	75	5.9	10.0	59.0	1.0	0
WMAIN-00910	Cast Iron, Assumed	12"	33.0	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00919	Cast Iron, Assumed	12"	645.4	1959	58	0.3	0	1	75	5.9	7.7	45.6	0.8	17
WMAIN-00920	Cast Iron, Assumed	12"	642.4	1940	77	0	0	1	75	5	10.0	50.0	1.0	0
WMAIN-00922	Cast Iron, Assumed	12"	358.9	1940	77	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00945	Cast Iron, Assumed	12"	204.3	1909	108	0.3	0	1	75	5.9	10.0	59.0	1.0	0
WMAIN-00946	Cast Iron, Assumed	12"	203.9	1979	38	1	0	1	75	8	5.1	40.5	0.5	37
WMAIN-00951	Cast Iron, Assumed	12"	488.0	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-00952	Cast Iron, Assumed	12"	23.6	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-00975	Cast Iron, Assumed	12"	1099.0	1959	58	0.3	0	1	75	5.9	7.7	45.6	0.8	17
WMAIN-00985	Cast Iron, Assumed	12"	13.2	1947	70	0.2	0	1	75	5.6	9.3	52.3	0.9	5
WMAIN-00986	Cast Iron, Assumed	12"	93.6	1947	70	0.2	0	1	75	5.6	9.3	52.3	0.9	5
WMAIN-00993	Cast Iron, Assumed	12"	248.7	1947	70	0.8	1	1	75	9.4	9.3	87.7	0.9	5
WMAIN-00999	Cast Iron, Assumed	12"	269.6	1950	67	0.3	0	1	75	5.9	8.9	52.7	0.9	8
WMAIN-01000	Cast Iron, Assumed	12"	132.1	1950	67	0.3	0	1	75	5.9	8.9	52.7	0.9	8
WMAIN-01005	Cast Iron, Assumed	12"	132.2	1998	19	1	0	1	75	8	2.5	20.3	0.3	56
WMAIN-01009	Cast Iron, Assumed	12"	487.7	1909	108	0.2	0	1	75	5.6	10.0	56.0	1.0	0
WMAIN-01030	Cast Iron, Assumed	12"	24.0	1934	83	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-01031	Cast Iron, Assumed	12"	1009.0	1934	83	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-01045	Cast Iron, Assumed	12"	156.6	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01046	Cast Iron, Assumed	12"	20.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01062	Cast Iron, Assumed	12"	105.6	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01063	Cast Iron, Assumed	12"	11.7	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01064	Cast Iron, Assumed	12"	70.0	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01065	Cast Iron, Assumed	12"	14.5	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01066	Cast Iron, Assumed	12"	57.8	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01067	Cast Iron, Assumed	12"	162.0	1950	67	0.3	0	1	75	5.9	8.9	52.7	0.9	8
WMAIN-01085	Cast Iron, Assumed	12"	525.5	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-01097	Cast Iron, Assumed	12"	649.0	1967	50	0.2	0	1	75	5.6	6.7	37.3	0.7	25
WMAIN-01101	Cast Iron, Assumed	12"	246.6	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-01102	Cast Iron, Assumed	12"	1326.6	1967	50	0.2	0	1	75	5.6	6.7	37.3	0.7	25
WMAIN-01105	Cast Iron, Assumed	12"	13.0	1998	19	0.3	0	1	75	5.9	2.5	14.9	0.3	56
WMAIN-01106	Cast Iron, Assumed	12"	697.0	1998	19	1	0	1	75	8	2.5	20.3	0.3	56
WMAIN-01130	Cast Iron, Assumed	12"	5.0	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01143	Cast Iron, Assumed	12"	54.0	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01144	Cast Iron, Assumed	12"	69.8	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01161	Cast Iron, Assumed	12"	24.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01163	Cast Iron, Assumed	12"	52.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01165	Cast Iron, Assumed	12"	10.0	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01167	Cast Iron, Assumed	12"	22.7	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01172	Cast Iron, Assumed	12"	59.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-01175	Cast Iron, Assumed	12"	11.9	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01176	Cast Iron, Assumed	12"	20.3	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01177	Cast Iron, Assumed	12"	88.3	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01178	Cast Iron, Assumed	12"	11.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01179	Cast Iron, Assumed	12"	9.9	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01180	Cast Iron, Assumed	12"	21.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01181	Cast Iron, Assumed	12"	144.0	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01182	Cast Iron, Assumed	12"	159.1	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01183	Cast Iron, Assumed	12"	404.5	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01184	Cast Iron, Assumed	12"	531.9	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01185	Cast Iron, Assumed	12"	25.8	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01187	Cast Iron, Assumed	12"	171.4	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01188	Cast Iron, Assumed	12"	19.3	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01189	Cast Iron, Assumed	12"	31.6	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01190	Cast Iron, Assumed	12"	221.9	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01191	Cast Iron, Assumed	12"	3.5	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01192	Cast Iron, Assumed	12"	88.0	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01193	Cast Iron, Assumed	12"	375.4	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01194	Cast Iron, Assumed	12"	204.5	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01195	Cast Iron, Assumed	12"	74.9	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01196	Cast Iron, Assumed	12"	55.0	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01197	Cast Iron, Assumed	12"	31.9	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01198	Cast Iron, Assumed	12"	36.3	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01199	Cast Iron, Assumed	12"	194.6	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01205	Cast Iron, Assumed	12"	292.7	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01206	Cast Iron, Assumed	12"	366.2	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01207	Cast Iron, Assumed	12"	544.1	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01208	Cast Iron, Assumed	12"	73.2	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01209	Cast Iron, Assumed	12"	73.9	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01210	Cast Iron, Assumed	12"	61.1	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01211	Cast Iron, Assumed	12"	2.6	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01250	Cast Iron, Assumed	12"	20.0	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01251	Cast Iron, Assumed	12"	106.2	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01260	Cast Iron, Assumed	12"	3.0	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01261	Cast Iron, Assumed	12"	18.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01307	Cast Iron, Assumed	12"	235.8	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01324	Cast Iron, Assumed	12"	100.2	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01348	Cast Iron, Assumed	12"	532.3	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01364	Cast Iron, Assumed	12"	33.2	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01365	Cast Iron, Assumed	12"	7.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01366	Cast Iron, Assumed	12"	6.3	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01368	Cast Iron, Assumed	12"	0.0	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01369	Cast Iron, Assumed	12"	0.0	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01370	Cast Iron, Assumed	12"	90.7	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01371	Cast Iron, Assumed	12"	25.7	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01372	Cast Iron, Assumed	12"	105.5	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01373	Cast Iron, Assumed	12"	31.2	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01374	Cast Iron, Assumed	12"	135.1	1969	48	0.8	0	1	75	7.4	6.4	47.4	0.6	27
WMAIN-01379	Cast Iron, Assumed	12"	57.9	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01380	Cast Iron, Assumed	12"	297.6	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01381	Cast Iron, Assumed	12"	24.3	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01382	Cast Iron, Assumed	12"	145.9	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01383	Cast Iron, Assumed	12"	45.1	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01384	Cast Iron, Assumed	12"	59.4	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01385	Cast Iron, Assumed	12"	52.9	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01386	Cast Iron, Assumed	12"	63.4	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01387	Cast Iron, Assumed	12"	55.5	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01388	Cast Iron, Assumed	12"	35.4	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01390	Cast Iron, Assumed	12"	5.6	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01392	Cast Iron, Assumed	12"	5.9	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01394	Cast Iron, Assumed	12"	62.8	2008	8	1	0	1	75	8	1.1	8.5	0.1	67

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-01395	Cast Iron, Assumed	12"	28.0	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01396	Cast Iron, Assumed	12"	40.4	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01397	Cast Iron, Assumed	12"	2.0	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01398	Cast Iron, Assumed	12"	63.0	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01399	Cast Iron, Assumed	12"	36.5	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01400	Cast Iron, Assumed	12"	21.8	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01401	Cast Iron, Assumed	12"	29.1	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01402	Cast Iron, Assumed	12"	15.2	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01403	Cast Iron, Assumed	12"	0.0	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01404	Cast Iron, Assumed	12"	146.0	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01405	Cast Iron, Assumed	12"	31.9	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01406	Cast Iron, Assumed	12"	11.0	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01407	Cast Iron, Assumed	12"	29.5	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01408	Cast Iron, Assumed	12"	13.4	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01409	Cast Iron, Assumed	12"	14.1	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01410	Cast Iron, Assumed	12"	9.6	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01411	Cast Iron, Assumed	12"	9.5	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01412	Cast Iron, Assumed	12"	2.1	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01413	Cast Iron, Assumed	12"	7.5	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01414	Cast Iron, Assumed	12"	2.1	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01415	Cast Iron, Assumed	12"	6.4	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01417	Cast Iron, Assumed	12"	21.5	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01418	Cast Iron, Assumed	12"	0.5	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01429	Cast Iron, Assumed	12"	10.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01430	Cast Iron, Assumed	12"	5.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01435	Cast Iron, Assumed	12"	53.2	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01436	Cast Iron, Assumed	12"	1.0	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01437	Cast Iron, Assumed	12"	6.6	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01438	Cast Iron, Assumed	12"	319.1	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01439	Cast Iron, Assumed	12"	154.1	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01456	Cast Iron, Assumed	12"	8.1	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01457	Cast Iron, Assumed	12"	37.7	1959	58	0.3	0	1	75	5.9	7.7	45.6	0.8	17
WMAIN-01459	Cast Iron, Assumed	12"	93.1	1959	58	0.3	0	1	75	5.9	7.7	45.6	0.8	17
WMAIN-01460	Cast Iron, Assumed	12"	82.6	1959	58	0.3	0	1	75	5.9	7.7	45.6	0.8	17
WMAIN-01461	Cast Iron, Assumed	12"	21.0	1959	58	0.3	0	1	75	5.9	7.7	45.6	0.8	17
WMAIN-01462	Cast Iron, Assumed	12"	186.7	1959	58	0.3	0	1	75	5.9	7.7	45.6	0.8	17
WMAIN-01463	Cast Iron, Assumed	12"	641.9	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01464	Cast Iron, Assumed	12"	450.7	1959	58	0.3	0	1	75	5.9	7.7	45.6	0.8	17
WMAIN-01465	Cast Iron, Assumed	12"	360.6	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01466	Cast Iron, Assumed	12"	261.9	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01467	Cast Iron, Assumed	12"	16.7	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-01513	Cast Iron, Assumed	12"	3.6	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01514	Cast Iron, Assumed	12"	185.4	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01515	Cast Iron, Assumed	12"	122.9	1950	67	0.3	0	1	75	5.9	8.9	52.7	0.9	8
WMAIN-01516	Cast Iron, Assumed	12"	29.5	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01517	Cast Iron, Assumed	12"	25.8	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01521	Cast Iron, Assumed	12"	101.8	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01532	Cast Iron, Assumed	12"	61.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01533	Cast Iron, Assumed	12"	6.2	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01534	Cast Iron, Assumed	12"	20.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01535	Cast Iron, Assumed	12"	6.2	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01536	Cast Iron, Assumed	12"	102.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01537	Cast Iron, Assumed	12"	10.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01544	Cast Iron, Assumed	12"	29.9	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01549	Cast Iron, Assumed	12"	382.5	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-01550	Cast Iron, Assumed	12"	8.3	1909	108	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-01551	Cast Iron, Assumed	12"	10.4	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01552	Cast Iron, Assumed	12"	30.7	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01553	Cast Iron, Assumed	12"	10.4	2008	8	1	0	1	75	8	1.1	8.5	0.1	67
WMAIN-01563	Cast Iron, Assumed	12"	55.7	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01564	Cast Iron, Assumed	12"	23.7	2008	9	1	0	1	75	8	1.2	9.6	0.1	66

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WMAIN-01565	Cast Iron, Assumed	12"	63.5	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01566	Cast Iron, Assumed	12"	18.8	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01567	Cast Iron, Assumed	12"	35.4	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01568	Cast Iron, Assumed	12"	3.2	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01569	Cast Iron, Assumed	12"	51.4	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01570	Cast Iron, Assumed	12"	17.7	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01571	Cast Iron, Assumed	12"	22.6	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01572	Cast Iron, Assumed	12"	0.4	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01573	Cast Iron, Assumed	12"	10.2	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01574	Cast Iron, Assumed	12"	35.7	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01575	Cast Iron, Assumed	12"	27.0	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01576	Cast Iron, Assumed	12"	44.0	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01577	Cast Iron, Assumed	12"	52.7	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01578	Cast Iron, Assumed	12"	22.0	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01579	Cast Iron, Assumed	12"	56.2	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01580	Cast Iron, Assumed	12"	11.8	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01581	Cast Iron, Assumed	12"	10.2	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01582	Cast Iron, Assumed	12"	109.6	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01583	Cast Iron, Assumed	12"	60.1	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01584	Cast Iron, Assumed	12"	9.4	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01585	Cast Iron, Assumed	12"	54.3	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01586	Cast Iron, Assumed	12"	4.4	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01587	Cast Iron, Assumed	12"	22.9	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01588	Cast Iron, Assumed	12"	19.7	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01589	Cast Iron, Assumed	12"	0.9	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01590	Cast Iron, Assumed	12"	86.9	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01591	Cast Iron, Assumed	12"	7.4	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01592	Cast Iron, Assumed	12"	28.9	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01593	Cast Iron, Assumed	12"	26.9	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01594	Cast Iron, Assumed	12"	8.3	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01595	Cast Iron, Assumed	12"	4.2	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01596	Cast Iron, Assumed	12"	72.6	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01597	Cast Iron, Assumed	12"	39.5	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01598	Cast Iron, Assumed	12"	48.1	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01599	Cast Iron, Assumed	12"	2.6	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01600	Cast Iron, Assumed	12"	51.6	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01601	Cast Iron, Assumed	12"	33.4	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01602	Cast Iron, Assumed	12"	41.9	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01603	Cast Iron, Assumed	12"	1.6	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01604	Cast Iron, Assumed	12"	17.9	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01605	Cast Iron, Assumed	12"	53.1	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01606	Cast Iron, Assumed	12"	56.8	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01607	Cast Iron, Assumed	12"	2.7	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01608	Cast Iron, Assumed	12"	16.4	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01609	Cast Iron, Assumed	12"	46.9	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01610	Cast Iron, Assumed	12"	63.5	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01611	Cast Iron, Assumed	12"	57.5	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01612	Cast Iron, Assumed	12"	24.7	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01613	Cast Iron, Assumed	12"	32.3	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01614	Cast Iron, Assumed	12"	12.6	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01615	Cast Iron, Assumed	12"	43.8	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01616	Cast Iron, Assumed	12"	7.3	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01622	Cast Iron, Assumed	12"	8.2	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01623	Cast Iron, Assumed	12"	20.5	2008	9	1	0	1	75	8	1.2	9.6	0.1	66
WMAIN-01646	Cast Iron, Assumed	12"	52.6	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01691	Cast Iron, Assumed	12"	78.7	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-01702	Cast Iron, Assumed	12"	2.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01703	Cast Iron, Assumed	12"	166.1	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01734	Cast Iron, Assumed	12"	604.1	1934	83	0.8	0	1	75	7.4	10.0	74.0	1.0	0
WMAIN-01735	Cast Iron, Assumed	12"	5.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00001	Ductile Iron	12"	55.6	1959	58	1	0	1	90	8	6.4	51.6	0.6	32

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00002	Ductile Iron	12"	13.5	1959	58	1	0	1	90	8	6.4	51.6	0.6	32
<Null>	Ductile Iron	12"	559.0	2012	5	0.2	0	1	90	5.6	0.6	3.1	0.1	85
<Null>	Ductile Iron	12"	601.2	2012	5	0.2	0	1	90	5.6	0.6	3.1	0.1	85
WMAIN-00228	Ductile Iron, Assumed	12"	1037.4	1971	46	0.8	0	1	90	7.4	5.1	37.8	0.5	44
WMAIN-00856	Ductile Iron, Assumed	12"	441.1	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00857	Ductile Iron, Assumed	12"	478.2	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00858	Ductile Iron, Assumed	12"	383.6	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00861	Ductile Iron, Assumed	12"	179.9	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00862	Ductile Iron, Assumed	12"	86.2	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00863	Ductile Iron, Assumed	12"	26.2	2007	10	1	0	1	90	8	1.1	8.9	0.1	80
WMAIN-00864	Ductile Iron, Assumed	12"	51.8	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00865	Ductile Iron, Assumed	12"	17.8	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-00866	Ductile Iron, Assumed	12"	62.5	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00867	Ductile Iron, Assumed	12"	44.4	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00869	Ductile Iron, Assumed	12"	188.4	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00870	Ductile Iron, Assumed	12"	3.1	2007	10	1	0	1	90	8	1.1	8.9	0.1	80
WMAIN-00871	Ductile Iron, Assumed	12"	1.8	2007	10	1	0	1	90	8	1.1	8.9	0.1	80
WMAIN-00872	Ductile Iron, Assumed	12"	3.0	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00873	Ductile Iron, Assumed	12"	1.6	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00874	Ductile Iron, Assumed	12"	2.0	2007	10	1	0	1	90	8	1.1	8.9	0.1	80
WMAIN-00875	Ductile Iron, Assumed	12"	4.0	2007	10	1	0	1	90	8	1.1	8.9	0.1	80
WMAIN-00876	Ductile Iron, Assumed	12"	404.4	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00877	Ductile Iron, Assumed	12"	72.0	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-00878	Ductile Iron, Assumed	12"	72.0	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-00879	Ductile Iron, Assumed	12"	2.0	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-00880	Ductile Iron, Assumed	12"	2.0	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-00881	Ductile Iron, Assumed	12"	16.4	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-00882	Ductile Iron, Assumed	12"	18.6	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-00883	Ductile Iron, Assumed	12"	160.3	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-00884	Ductile Iron, Assumed	12"	5.9	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-00885	Ductile Iron, Assumed	12"	4.2	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-00889	Ductile Iron, Assumed	12"	237.9	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00890	Ductile Iron, Assumed	12"	108.6	2007	10	1	0	1	90	8	1.1	8.9	0.1	80
WMAIN-00892	Ductile Iron, Assumed	12"	30.6	2007	10	1	0	1	90	8	1.1	8.9	0.1	80
WMAIN-00893	Ductile Iron, Assumed	12"	23.0	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00894	Ductile Iron, Assumed	12"	265.6	2002	15	1	0	1	90	8	1.7	13.3	0.2	75
WMAIN-00895	Ductile Iron, Assumed	12"	3.4	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-01134	Ductile Iron, Assumed	12"	24.7	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01135	Ductile Iron, Assumed	12"	6.5	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01142	Ductile Iron, Assumed	12"	38.0	2007	10	1	0	1	90	8	1.1	8.9	0.1	80
WMAIN-01169	Ductile Iron, Assumed	12"	15.0	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01200	Ductile Iron, Assumed	12"	116.3	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01201	Ductile Iron, Assumed	12"	32.5	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01202	Ductile Iron, Assumed	12"	17.2	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01203	Ductile Iron, Assumed	12"	238.8	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01204	Ductile Iron, Assumed	12"	432.1	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01263	Ductile Iron, Assumed	12"	3.3	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01264	Ductile Iron, Assumed	12"	3.4	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01300	Ductile Iron, Assumed	12"	67.0	2012	5	1	0	1	90	8	0.6	4.4	0.1	85
WMAIN-01301	Ductile Iron, Assumed	12"	649.9	2012	5	1	0	1	90	8	0.6	4.4	0.1	85
WMAIN-01302	Ductile Iron, Assumed	12"	75.9	2012	5	1	0	1	90	8	0.6	4.4	0.1	85
WMAIN-01303	Ductile Iron, Assumed	12"	47.5	2012	5	1	0	1	90	8	0.6	4.4	0.1	85
WMAIN-01304	Ductile Iron, Assumed	12"	86.5	2012	5	1	0	1	90	8	0.6	4.4	0.1	85
WMAIN-01305	Ductile Iron, Assumed	12"	54.5	2012	5	1	0	1	90	8	0.6	4.4	0.1	85
WMAIN-01306	Ductile Iron, Assumed	12"	329.9	2012	5	1	0	1	90	8	0.6	4.4	0.1	85
WMAIN-01313	Ductile Iron, Assumed	12"	11.8	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01349	Ductile Iron, Assumed	12"	3.6	2006	11	1	0	1	90	8	1.2	9.8	0.1	79
WMAIN-01416	Ductile Iron, Assumed	12"	52.7	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01419	Ductile Iron, Assumed	12"	60.0	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01420	Ductile Iron, Assumed	12"	48.7	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01423	Ductile Iron, Assumed	12"	60.9	2008	8	1	0	1	90	8	0.9	7.1	0.1	82

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-01424	Ductile Iron, Assumed	12"	35.1	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01425	Ductile Iron, Assumed	12"	72.2	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01426	Ductile Iron, Assumed	12"	50.2	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01431	Ductile Iron, Assumed	12"	13.2	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01432	Ductile Iron, Assumed	12"	8.8	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01433	Ductile Iron, Assumed	12"	6.4	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01434	Ductile Iron, Assumed	12"	19.3	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01526	Ductile Iron, Assumed	12"	24.1	2007	10	0.3	0	1	90	5.9	1.1	6.6	0.1	80
WMAIN-01531	Ductile Iron, Assumed	12"	31.3	2007	10	1	0	1	90	8	1.1	8.9	0.1	80
WMAIN-01554	Ductile Iron, Assumed	12"	9.2	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01555	Ductile Iron, Assumed	12"	10.2	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01556	Ductile Iron, Assumed	12"	16.7	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01557	Ductile Iron, Assumed	12"	35.4	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01558	Ductile Iron, Assumed	12"	14.9	2008	8	1	0	1	90	8	0.9	7.1	0.1	82
WMAIN-01560	Ductile Iron, Assumed	12"	3.2	2012	5	1	0	1	90	8	0.6	4.4	0.1	85
WMAIN-01561	Ductile Iron, Assumed	12"	1.1	2012	5	1	0	1	90	8	0.6	4.4	0.1	85
WMAIN-00101	Cast Iron, Assumed	16"	31.3	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00102	Cast Iron, Assumed	16"	334.1	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00103	Cast Iron, Assumed	16"	363.8	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00104	Cast Iron, Assumed	16"	319.2	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00105	Cast Iron, Assumed	16"	7.0	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00106	Cast Iron, Assumed	16"	9.4	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00107	Cast Iron, Assumed	16"	311.3	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00115	Cast Iron, Assumed	16"	9.4	1937	80	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00417	Cast Iron, Assumed	16"	9.4	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00501	Cast Iron, Assumed	16"	69.3	1934	83	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00502	Cast Iron, Assumed	16"	30.7	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00505	Cast Iron, Assumed	16"	9.4	1934	83	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00719	Cast Iron, Assumed	16"	15.5	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00720	Cast Iron, Assumed	16"	62.4	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00763	Cast Iron, Assumed	16"	250.2	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-00810	Cast Iron, Assumed	16"	151.1	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-00840	Cast Iron, Assumed	16"	304.0	1947	70	1	0	1	75	8	9.3	74.7	0.9	5
WMAIN-00917	Cast Iron, Assumed	16"	266.5	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-00918	Cast Iron, Assumed	16"	569.8	1959	58	0.3	0	1	75	5.9	7.7	45.6	0.8	17
WMAIN-00921	Cast Iron, Assumed	16"	956.2	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-00924	Cast Iron, Assumed	16"	731.2	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-00940	Cast Iron, Assumed	16"	61.4	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00990	Cast Iron, Assumed	16"	84.3	1947	70	1	0	1	75	8	9.3	74.7	0.9	5
WMAIN-01012	Cast Iron, Assumed	16"	477.6	1950	67	0	0	1	75	5	8.9	44.7	0.9	8
WMAIN-01013	Cast Iron, Assumed	16"	149.8	1934	83	0.2	0	1	75	5.6	10.0	56.0	1.0	0
WMAIN-01014	Cast Iron, Assumed	16"	98.5	1934	83	0.2	0	1	75	5.6	10.0	56.0	1.0	0
WMAIN-01015	Cast Iron, Assumed	16"	281.6	1934	83	0.2	1	1	75	7.6	10.0	76.0	1.0	0
WMAIN-01052	Cast Iron, Assumed	16"	110.6	1959	58	0.2	0	1	75	5.6	7.7	43.3	0.8	17
WMAIN-01053	Cast Iron, Assumed	16"	164.5	1959	58	0.2	0	1	75	5.6	7.7	43.3	0.8	17
WMAIN-01058	Cast Iron, Assumed	16"	84.2	1959	58	0.2	0	1	75	5.6	7.7	43.3	0.8	17
WMAIN-01059	Cast Iron, Assumed	16"	53.1	1959	58	0.2	0	1	75	5.6	7.7	43.3	0.8	17
WMAIN-01060	Cast Iron, Assumed	16"	130.4	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-01084	Cast Iron, Assumed	16"	64.4	1937	80	0.3	0	1	75	5.9	10.0	59.0	1.0	0
WMAIN-01098	Cast Iron, Assumed	16"	623.2	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-01131	Cast Iron, Assumed	16"	5.4	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01159	Cast Iron, Assumed	16"	23.5	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01255	Cast Iron, Assumed	16"	404.0	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-01449	Cast Iron, Assumed	16"	40.3	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01455	Cast Iron, Assumed	16"	0.3	1959	58	0.3	0	1	75	5.9	7.7	45.6	0.8	17
WMAIN-01491	Cast Iron, Assumed	16"	59.8	1967	50	1	0	1	75	8	6.7	53.3	0.7	25
WMAIN-01559	Cast Iron, Assumed	16"	49.9	1959	58	1	0	1	75	8	7.7	61.9	0.8	17
WMAIN-00941	Ductile Iron, Assumed	16"	110.2	1950	67	1	0	1	90	8	7.4	59.6	0.7	23
WMAIN-00942	Ductile Iron, Assumed	16"	421.1	1950	67	0.2	0.5	1	90	6.6	7.4	49.1	0.7	23
WMAIN-01054	Ductile Iron, Assumed	16"	155.2	2012	5	0.2	0	1	90	5.6	0.6	3.1	0.1	85
WMAIN-01055	Ductile Iron, Assumed	16"	92.5	2012	5	0.2	0	1	90	5.6	0.6	3.1	0.1	85

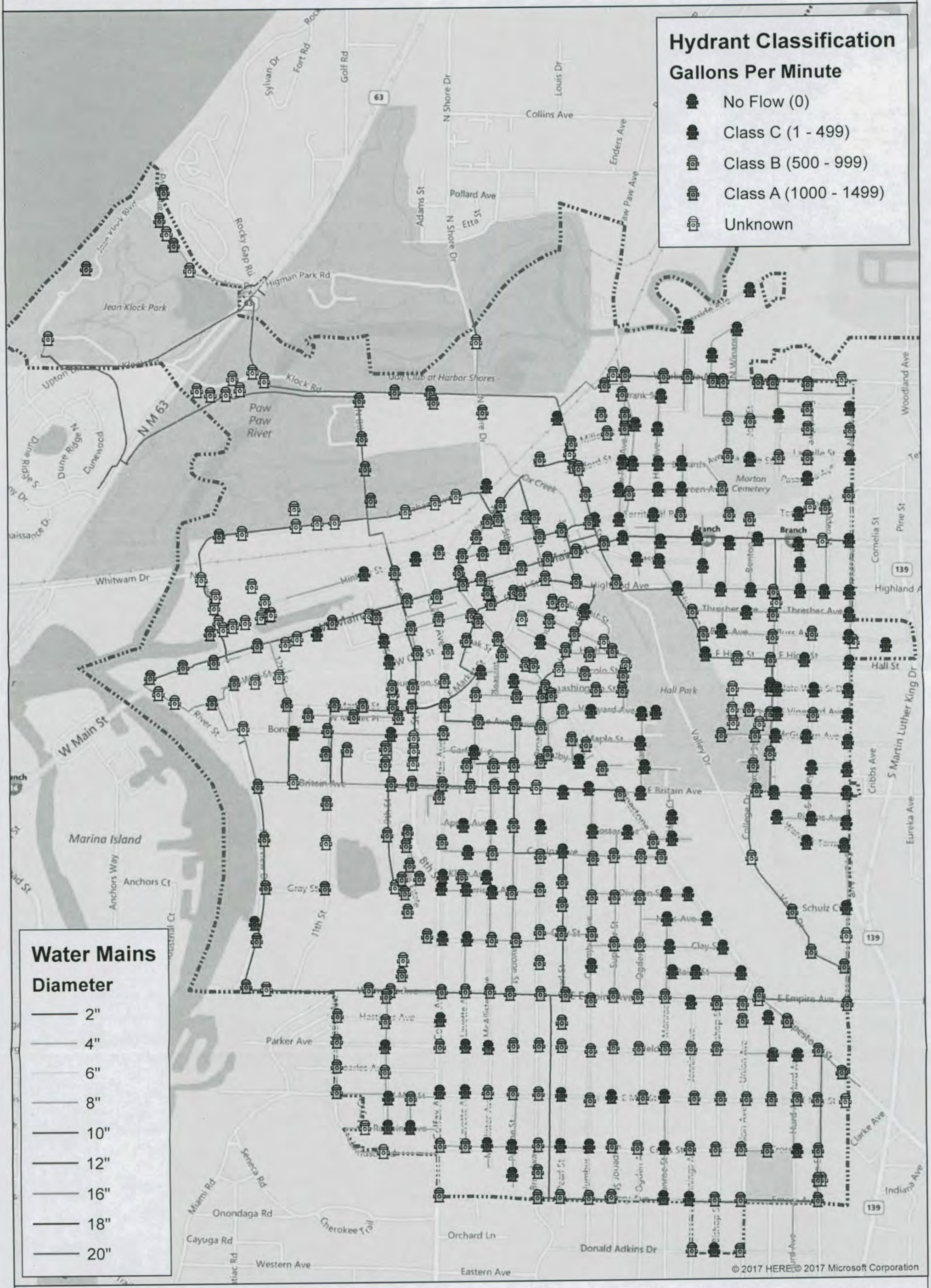
GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-01056	Ductile Iron, Assumed	16"	93.3	2012	5	0.2	0	1	90	5.6	0.6	3.1	0.1	85
WMAIN-01057	Ductile Iron, Assumed	16"	397.8	2012	5	0.2	0	1	90	5.6	0.6	3.1	0.1	85
WMAIN-01061	Ductile Iron, Assumed	16"	420.8	2012	5	0.2	0	1	90	5.6	0.6	3.1	0.1	85
WMAIN-01318	Ductile Iron, Assumed	16"	665.8	Pre-1999	43	1	0	1	90	8	4.8	38.2	0.5	47
WMAIN-00085	Cast Iron, Assumed	18"	181.8	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00427	Cast Iron, Assumed	18"	6.2	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00828	Cast Iron, Assumed	18"	111.3	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00904	Cast Iron, Assumed	18"	98.2	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00905	Cast Iron, Assumed	18"	196.9	1969	48	1	0	1	75	8	6.4	51.2	0.6	27
WMAIN-00906	Cast Iron, Assumed	18"	303.4	1969	48	1	0	1	75	8	6.4	51.2	0.6	27
WMAIN-00943	Cast Iron, Assumed	18"	123.0	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01447	Cast Iron, Assumed	18"	89.7	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01448	Cast Iron, Assumed	18"	70.7	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00112	Cast Iron, Assumed	20"	65.5	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00150	Cast Iron, Assumed	20"	174.5	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00151	Cast Iron, Assumed	20"	44.1	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00153	Cast Iron, Assumed	20"	15.2	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00154	Cast Iron, Assumed	20"	52.8	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00157	Cast Iron, Assumed	20"	703.3	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00508	Cast Iron, Assumed	20"	32.1	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00509	Cast Iron, Assumed	20"	97.8	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00591	Cast Iron, Assumed	20"	909.8	1968	49	0.2	0	1	75	5.6	6.5	36.6	0.7	26
WMAIN-00594	Cast Iron, Assumed	20"	354.1	1968	49	0.2	0	1	75	5.6	6.5	36.6	0.7	26
WMAIN-00595	Cast Iron, Assumed	20"	645.2	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00598	Cast Iron, Assumed	20"	93.9	1968	49	0.2	0	1	75	5.6	6.5	36.6	0.7	26
WMAIN-00694	Cast Iron, Assumed	20"	9.4	1934	83	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00712	Cast Iron, Assumed	20"	87.0	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00713	Cast Iron, Assumed	20"	647.0	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00716	Cast Iron, Assumed	20"	9.4	1950	67	1	0	1	75	8	8.9	71.5	0.9	8
WMAIN-00734	Cast Iron, Assumed	20"	589.4	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00735	Cast Iron, Assumed	20"	318.6	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00738	Cast Iron, Assumed	20"	9.4	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00752	Cast Iron, Assumed	20"	1548.1	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00753	Cast Iron, Assumed	20"	56.6	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00786	Cast Iron, Assumed	20"	22.9	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00790	Cast Iron, Assumed	20"	352.6	1909	108	0	0.8	1	75	6.6	10.0	66.0	1.0	0
WMAIN-00832	Cast Iron, Assumed	20"	1003.0	1968	49	1	0	1	75	8	6.5	52.3	0.7	26
WMAIN-00926	Cast Iron, Assumed	20"	990.2	2000	17	0	0	1	75	5	2.3	11.3	0.2	58
WMAIN-00931	Cast Iron, Assumed	20"	88.7	1947	70	1	0	1	75	8	9.3	74.7	0.9	5
WMAIN-00932	Cast Iron, Assumed	20"	195.5	1947	70	1	0	1	75	8	9.3	74.7	0.9	5
WMAIN-00933	Cast Iron, Assumed	20"	173.2	1947	70	0.2	0	1	75	5.6	9.3	52.3	0.9	5
WMAIN-00936	Cast Iron, Assumed	20"	921.5	1950	67	0.2	0	1	75	5.6	8.9	50.0	0.9	8
WMAIN-00937	Cast Iron, Assumed	20"	30.6	1950	67	0.2	0	1	75	5.6	8.9	50.0	0.9	8
WMAIN-00991	Cast Iron, Assumed	20"	67.7	1947	70	1	0	1	75	8	9.3	74.7	0.9	5
WMAIN-01117	Cast Iron, Assumed	20"	1616.9	2000	17	1	0	1	75	8	2.3	18.1	0.2	58
WMAIN-01119	Cast Iron, Assumed	20"	2237.2	2000	17	1	0.5	1	75	9	2.3	20.4	0.2	58
WMAIN-01120	Cast Iron, Assumed	20"	881.0	1947	70	1	0	1	75	8	9.3	74.7	0.9	5
WMAIN-01361	Cast Iron, Assumed	20"	51.6	1947	70	0.8	0	1	75	7.4	9.3	69.1	0.9	5
WMAIN-01538	Cast Iron, Assumed	20"	25.1	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-01539	Cast Iron, Assumed	20"	111.0	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
<Null>	Cast Iron, Assumed	20"	225.4	1947	70	0.2	0	1	75	5.6	9.3	52.3	0.9	5
WMAIN-00752	Cast Iron, Assumed	20"	790.0	1909	108	1	0	1	75	8	10.0	80.0	1.0	0
WMAIN-00654	Ductile Iron, Assumed	20"	108.4	1974	43	1	0	1	90	8	4.8	38.2	0.5	47
WMAIN-00780	Ductile Iron, Assumed	20"	396.9	1993	24	1	0	1	90	8	2.7	21.3	0.3	66
WMAIN-00781	Ductile Iron, Assumed	20"	52.0	1993	24	0.3	0	1	90	5.9	2.7	15.7	0.3	66
WMAIN-00782	Ductile Iron, Assumed	20"	4.5	1993	24	0.3	0	1	90	5.9	2.7	15.7	0.3	66
WMAIN-00783	Ductile Iron, Assumed	20"	10.3	1993	24	0.3	0	1	90	5.9	2.7	15.7	0.3	66
WMAIN-00784	Ductile Iron, Assumed	20"	29.8	1993	24	0.3	0	1	90	5.9	2.7	15.7	0.3	66
WMAIN-00791	Ductile Iron, Assumed	20"	1575.5	1950	67	1	0	1	90	8	7.4	59.6	0.7	23
WMAIN-00925	Ductile Iron, Assumed	20"	157.0	1974	43	1	0	1	90	8	4.8	38.2	0.5	47
WMAIN-00927	Ductile Iron, Assumed	20"	1624.5	1974	43	1	0	1	90	8	4.8	38.2	0.5	47

GIS Object ID	Material	Diameter (Inch)	Length of Pipe (Feet)	Assumed Install Date	Age in 2017	Proximity to Road Value (0 - 1)	Proximity to Buildings Value (0 - 1)	Size Value (0 - 1)	Effective Excepted Life (EEL)	Consequence of Failure (COF) (0 = Low, 10 = High)	Probability of Failure (POF) (0 = Low, 10 = High)	Criticality (COF x POF) (0 = Low, 100 = Critical)	Consumed Pipe (0 = New, 1 = Consumed)	Remaining Useful Life (Years)
WMAIN-00928	Ductile Iron, Assumed	20"	690.1	1974	43	1	0	1	90	8	4.8	38.2	0.5	47
WMAIN-00929	Ductile Iron, Assumed	20"	506.3	Pre-2012	43	0	0	1	90	5	4.8	23.9	0.5	47
WMAIN-00930	Ductile Iron, Assumed	20"	112.2	1974	43	0	0	1	90	5	4.8	23.9	0.5	47
WMAIN-00934	Ductile Iron, Assumed	20"	259.2	1974	43	1	0	1	90	8	4.8	38.2	0.5	47
WMAIN-00935	Ductile Iron, Assumed	20"	300.2	1974	43	1	0	1	90	8	4.8	38.2	0.5	47
WMAIN-00953	Ductile Iron, Assumed	20"	761.6	1993	24	0.8	0	1	90	7.4	2.7	19.7	0.3	66
WMAIN-01033	Ductile Iron, Assumed	20"	211.7	1950	67	1	0	1	90	8	7.4	59.6	0.7	23
WMAIN-01034	Ductile Iron, Assumed	20"	176.0	1950	67	0	0	1	90	5	7.4	37.2	0.7	23
WMAIN-01109	Ductile Iron, Assumed	20"	2055.7	1993	24	0.8	0	1	90	7.4	2.7	19.7	0.3	66
WMAIN-01118	Ductile Iron, Assumed	20"	87.4	2000	17	1	0	1	90	8	1.9	15.1	0.2	73
WMAIN-01121	Ductile Iron, Assumed	20"	303.0	1974	43	0	0	1	90	5	4.8	23.9	0.5	47
WMAIN-01122	Ductile Iron, Assumed	20"	17.8	2000	17	0.3	0	1	90	5.9	1.9	11.1	0.2	73
WMAIN-01123	Ductile Iron, Assumed	20"	19.9	2000	17	0.3	0	1	90	5.9	1.9	11.1	0.2	73
WMAIN-01124	Ductile Iron, Assumed	20"	228.6	1974	43	0.2	0	1	90	5.6	4.8	26.8	0.5	47
WMAIN-01125	Ductile Iron, Assumed	20"	572.0	2000	17	0.3	0	1	90	5.9	1.9	11.1	0.2	73
WMAIN-01126	Ductile Iron, Assumed	20"	544.6	2000	17	0	0	1	90	5	1.9	9.4	0.2	73
WMAIN-01127	Ductile Iron, Assumed	20"	826.7	1974	43	0	0	1	90	5	4.8	23.9	0.5	47
WMAIN-01363	Ductile Iron, Assumed	20"	60.5	1950	67	1	0	1	90	8	7.4	59.6	0.7	23
WMAIN-01696	Ductile Iron, Assumed	20"	53.6	1993	24	1	0	1	90	8	2.7	21.3	0.3	66

APPENDIX B

2017 HYDRANT CLASSIFICATION MAP

Hydrants by Classification



City of Benton Harbor, Michigan

0 0.125 0.25 0.5 Mi

ABONMARCHE
Confidence By Design

Prepared: September 2017



HYDRANT FLOW
Legend: Fire Flow (Available) (gpm)

<=	500
<=	750
<=	1,000
<=	1,500

Color Coding Legend
Pipe: Diameter (in)

<=	2.0
<=	4.0
<=	6.0
<=	8.0
<=	10.0
<=	12.0
<=	16.0
<=	18.0
<=	20.0

NO: | REVISION DESCRIPTION: | BY: | DATE:

ABONMARCHE
Benton Orchard Mattawan Portage South Haven
Dowagiac Lafayette South Bend Valparaiso
Engineering · Architecture · Land Surveying

PROJECT
BENTON HARBOR
WATER RELIABILITY STUDY

SHEET TITLE
TOTAL AVAILABLE FIRE FLOW CURRENT CONDITIONS

DRAWN BY: SRF
DESIGNED BY:
PM REVIEW:
QA/QC REVIEW:
DATE:
SEAL:

SIGNATURE:
DATE:

HARD COPY IS INTENDED TO BE 24" X 36" WHEN PLOTTED. SCALE(S) INDICATED AND GRAPHIC QUALITY MAY NOT BE ACCURATE FOR ANY OTHER SIZES

SCALE: HORZ: 1"=750' VERT:

ACI JOB #: 16-1099

SHEET NO: 1 of 1

APPENDIX C

WATER TOWER
INSPECTION REPORT

Dixon Engineering, Inc.

Maintenance Inspection

650,000 Gallon Double Ellipse

Britain Tank
Benton Harbor, Michigan

Inspection Performed: May 7, 2008
Report Prepared: May 21, 2008
Reviewed by Ira M. Gabin, P.E.: June 4, 2008

Phone (616) 374-3221
Fax (616) 374-7116
http://www.dixonengineering.net
dixon@dixonengineering.net

Dixon Engineering Inc.
1104 Third Ave. Lake Odessa, MI 48849

CONCLUSIONS:

1. The exterior coating is a urethane system that is in fair condition, has poor adhesion, and is slightly faded. Primary modes of failure are delamination, primer bleed-through, and spot coating breaks to the substrate. There are numerous areas of spot coating failure on the sidewalls and roof. Coating deterioration is moderate. The logo and lettering are extensively faded.

2. The wet interior coating is a three coat epoxy system that is in good condition. There are areas of minor spot failure on the floor and sidewalls. Above the high water line the coating is in good condition. The roof coating is deteriorating at open lap seams and on the roof beam edges. The roof beams and lap joints have minor edge corrosion.

3. Lower sections of some of the radial roof stiffeners have fallen into the tank's bowl.

RECOMMENDATIONS:

1. Schedule regular cleanings and inspections of the tank by an independent, third party as recommended by AWWA, or once every five years.

2. In three years budget to high pressure water jet (10,000 – 20,000 psi) spot power tool clean, and recoat the exterior with an acrylic system. The estimated cost is $195,000.

3. Or, abrasive blast clean the tank's exterior to a commercial grade (SSPC-SP6) condition inside a dust-tight, flexible-frame containment system, and recoat with a four coat polyurethane system. The estimated cost is $300,000, plus $75,000 for containment.

4. Repair and continue cathodic protection for wet interior surfaces. Use a qualified cathodic protection contractor for maintenance.

5. Repair foundation cracks and seal the surface with an epoxy coating. Cost would be incidental if completed with a major recoating project.

6. Recaulk areas of missing caulk between the tank's column baseplates and foundations. This could be done by in-house personnel.

7. Adjust the sway rods. The estimated cost is $3,000.

8. Install a 30 in. manway in the bottom of the riser. The estimated cost is $7,000.

9. Enlarge the roof hatch to 30 in. diameter. The estimated cost is $3,000.

10. Install a 25 ft. diameter, 42 in. high railing and a painter's rail on the roof. The estimated cost is $12,000.

11. Abrasive blast clean to a near white grade (SSPC-SP10), and paint the rusted pit piping. The estimated cost is $5,000.

12. Install a new wet interior ladder from the roof hatch to the bowl. Equip with a fall prevention device. Remove the damaged 4 ft. of ladder at the sidewall manway and replace with new. The estimated cost is $8,000.

13. Remove the roof ladder, and replace with hand rails from the step-off platform to the roof hand rail. The estimated cost is $10,000.

14. Weld plates over the cathodic protection lift holes in the roof and the hole in the roof vent. The estimated cost is $3,000.

15. Reinstall the fallen sections of the roof beams and inspect the remaining beams for repair. Budget $20,000.

A DISCUSSION on RESCUE/RETRIEVAL OPERATIONS from ELEVATED LEGGED STORAGE TANKS

A series of accidents involving falls from or in water tanks has highlighted inadequacies in tank design and a potentially greater problem. The rescue may be more dangerous than the original accident, with the potential for more loss of life or injury. Contractors and engineers are responsible for their own employees. Even with safety training and proper equipment, accidents will occur. Most rescue squads are local or neighboring fire departments, some with more practice than other departments. Elevated tanks were designed to store water, not for rescue or retrieval convenience. The following items would make working on and retrieval from water tanks safer. This discussion is offered as a starting point. We recommend that you meet with your rescue personnel and draft a rescue plan. A copy of the plan should be kept at the tank and with the rescue crew.

OSHA now requires 30 in. manways and hatches, and roof ladders are to be replaced with platforms, steps, and railings. We have always objected to replacement of ladders every other year as regulations change, especially on retrofit of existing tanks. We recommend the changes be made during the next major tank painting project.

Retrieval from Interior:

Current Access:

Access to the roof is from the leg, sidewall, and roof ladders. The ladders do not meet MiOSHA size standards. All exterior ladders contain a rail-type fall prevention device. There is a ladder in the wet interior from the sidewall manway to the bowl area. The wet interior ladder is in poor condition and does not have a fall prevention device. There is a 12 in. x 18 in. manway in the bottom of the riser, and a 24 in. diameter roof hatch to the wet interior. The top of the bowl riser does have a grate, but has a safety railing.

Modified Access:

Providing safe access to rescue personnel is essential. Replace the sidewall ladder so it extends straight up to a work platform with railings that surrounds the roof edge hatch. Replace the existing roof hatch with a 30 in. hatch with a lockable, rainproof lid. The existing hatch is too small for a rescue basket and rescue personnel with equipment. Replace the roof ladder with a series of steps and railings to permit access to the center of the roof standing upright. Install a movable fall prevention device on the railing. Install a 42 in. high railing on the roof. The railing would allow tie-off locations and increased safety during routine maintenance. The ladder and railing could be used your personnel when checking lights, vents, and security annually; or by antenna personnel. The railing could also be used for antenna mounting. Install a new wet interior ladder from the roof hatch to the floor, and repair the damaged section of the sidewall/bowl ladder. Once in the tank there is a 6 ft. diameter riser. A 42 in. high railing has been installed around the top of the riser. This provides a safe, although slippery, work environment for the rescue crew for retrieval down the riser.

Retrieval down Riser:

1. *Retrieval down through the riser is usually the safest method. Remove the new vent from the top center of the tank, and attach a winch or pulley system to a tripod set-up over the vent.*

2. *Raise and lower the basket through the riser and out the new 30 in. diameter manway at the bottom of the riser. Rescue personnel would also raise and lower all their equipment through the riser, and then leave the wet interior using the wet interior ladder with fall prevention. On the roof, personnel would be working from inside the security of a roof railing around the center attachment area and roof hatch.*

Modifications Necessary:

1. *Install a 30 in. manway in the bottom of the riser ($7,000).*

2. *Install a new sidewall ladder with a step-off platform and roof hand rails ($10,000).*

3. *Install a new 30 in. roof hatch ($3,000).*

4. *Install a roof railing ($12,000).*

5. *Install a new wet interior ladder ($8,000).*

Equipment:

Winch or pulley system and tripod.
Basket.
Fall prevention sliders.

COST SUMMARY:

Exterior high pressure water jet and recoat with acrylic system:	$195,000
Adjust sway rods:	3,000
Install 30 in. diameter manway in riser:	7,000
Install 30 in. roof hatch:	3,000
Install roof railing with painter's rail:	12,000
Paint pit piping:	5,000
Install new wet interior ladder with fall prevention:	8,000
Replace sidewall ladder with vertical ladder and step-off platform:	10,000
Weld cathodic caps and hole in roof vent:	3,000
Repair and replace roof beams and seal weld remaining beams and plug holes:	20,000
	$266,000
Engineering and contingencies:	53,000
Total:	**$319,000**

Because of the delaminating topcoat, a long-term strategy includes removal of the total coating system and abrasive blast cleaning and repainting with a dust-tight, flexible-frame containment system – add $180,000 to exterior repainting costs.

Note: The age and design of this tank with its lattice legs, struts, sway rods, and riveted construction make it very expensive to maintain compared to modern tanks. By comparison, the cost to overcoat the exterior of a modern 650,000 gallon pedestal-style tank is estimated at $85,000. The City is encouraged to discuss with its consulting engineers long-term planning for a new tank that would be much cheaper to maintain.

INSPECTION:

On May 7, 2008, Dixon Engineering, Inc. (DIXON) performed a maintenance inspection on the 650,000 gallon double ellipse water storage tank owned by the City of Benton Harbor, MI. Purposes of the inspection were to evaluate the interior and exterior coatings' performance and life expectancy; assess the condition of metal surfaces and appurtenances; review safety and health aspects; and make budgetary recommendations for continued maintenance of the tank. All recommendations are incorporated into this report, with budgeting estimates for repairs. Inspectors for DIXON were Roy Wise, Larry Houck, and Eric Binkowski. Scheduling and arrangements for the inspection were completed through Greg Alimenti.

CONDITIONS and RECOMMENDATIONS:

Exterior Coating Conditions:

The exterior coating is a multiple coat urethane system applied in 1990. It is beginning to chalk and fade, and there is a loss of gloss. Surfaces have faded due to exposure to ultraviolet rays, which is a normal occurrence for an exposed coating system. The coating is adequately protecting the metal and aesthetics are fair. While the coating may appear to have an acceptable aesthetic quality, the actual condition is poor. Adhesion is poor and many, minor coating breaks and exposed prime coat will soon appear, allowing rust to form on the surface.

The riser coating is in fair condition, with minor breaks, with small amounts of surface rust and rust staining. Primary methods of deterioration are spot coating breaks and topcoat delamination.

The bowl coating is in fair condition, with minor coating breaks, with small amounts of surface rust and rust staining. Primary method of deterioration is spot coating breaks to the primer.

The balcony coating is in fair condition.

The exterior sidewall coating is in fair condition. Primary methods of deterioration are delamination and spot coating breaks to the primer, with small amounts of surface rust and rust staining. The sidewalls and lower bowl areas are covered with light algae growth.

The exterior roof coating is in fair condition. Primary methods of deterioration are spot coating breaks and undercoat bleed-through. There are minor areas of primer bleed-through on the roof.

Lettering on the tank consists of "BENTON HARBOR" in two locations. Lettering is block-style. There is a sidewall logo (City logo with gulls).

Exterior Coating Recommendations:

Budget for exterior overcoating by 2011, or when aesthetics dictate. The estimated cost to recoat is $195,000.

High pressure water jet (10,000 – 20,000 psi) the existing coating to remove loose and poorly adhering topcoats. The coating system would consist of a spot prime coat on the bare metal, followed by two full coats of acrylic. The acrylic system had good gloss and sheen retention. The additional recoat would supply an added barrier thickness for continued service. This alternative was selected because the existing primer has good adhesion. The purpose of this procedure is to remove all the poorly adhering topcoat, leaving the primer in-place. This procedure greatly reduces the cost of the project and prolongs the life of the coating system. The system can be repainted every eight-to-ten years without disturbing the primer. With regular recoating, the life of the existing system could be extended twenty years or more before the coating would have to be completely removed. The tank would be removed from service during the project to reduce moisture condensation on the surface.

Wet Interior Coating Conditions:

The wet interior coating is an epoxy system applied by G & M Painting in 1990. The roof coating is in good condition, 99% intact, with the primary areas of deterioration along the lap seams, beam edges, and in crevices. The tank's roof contains open lap seams that have started to rust and stain, typical for a tank of this construction where the lap seams are open and not seal welded or caulked. Staining in the lap seams is not a concern, but should be monitored during future inspections for corrosion growth. Roof beam edge corrosion is typical, but should be corrected before structural loss of steel occurs. Coating deterioration is occurring along edges of some of the roof support beams. Rust is also occurring at the roof-to-beam junction.

The sidewall coating is in good condition, 99% intact. There is no significant damage at the high water line, which would be the area most affected by ice pressures and ice movement. Causes of deterioration are spot coating breaks, delamination from age, and abrasion. The coating is still protecting the metal, with the exception of several spot coating breaks. The sidewalls are covered with light mineral staining, which does not affect the integrity of the coating system.

Coating on the bottom of the tank is in good condition, 99% intact. Causes of deterioration are blisters, spot coating breaks from age, and abrasion. The coating is still protecting the metal, with the exception of some spot coating breaks. The bottom is covered with light mineral staining, which does not affect the integrity of the coating system. The bottom of the tank was covered with approximately ¼ in. of mud sediment that was flushed from the interior.

The riser coating is in fair condition, 95% intact. Causes of deterioration are pinholes, and spot coating breaks at lap seams and stitch welds. The coating is still protecting the metal, with the exception of several spot coating breaks. The riser coating is covered with light mineral staining, which does not affect the integrity of the coating system.

Wet Interior Coating Recommendations:

The existing coating system has not deteriorated to the point where replacement is warranted. The cathodic protection system did not appear to be functioning based on the severed lines at the top of the riser. Long-term budget for repainting in ten years. The estimated cost is $95,000.

Cathodic Protection Conditions:

The floating ring cathodic protection system appeared to be non-functional. The wiring has been sheared in the bowl. Coating breaks are present on the floor, sidewalls, and riser. Pitting has started at the coating breaks, as the cathodic system is not working.

Cathodic Protection Recommendations:

Repair and continue operation of the submerged cathodic protection system. Have a qualified cathodic protection contractor maintain the system. Repairs to the system should be completed as soon as possible to minimize corrosion growth at areas of coating breaks.

Site Conditions:

The tank site is small in size and is fenced with a single locking gate. There is an average size staging area for contractors' equipment. The site is maintained. There is residential development to the east and north, and commercial development to the west. Neighbors are close to the tank and extra precaution will need to be taken to keep paint and/or debris from neighbors' properties. The site is accessible from a municipal street, and the tank is located approximately 20 ft. from the main access road. Drainage for the site is towards the foundation.

Foundation Conditions:

The exposed column and riser foundations are in good condition and showed minor amounts of deterioration. Deterioration includes chipping and spalling. The concrete is spalled without rebar exposure. Differential settlement of the foundations has not occurred from freeze/thaw cycles. The top 6 in. of the foundations are exposed. Corrosion is occurring on some of the anchor bolt chairs.

Grout Conditions:

The grout is in poor condition around the column baseplates. 20 ft. of grout is missing between the bottom plates and column foundations.

Grout Recommendations:

Remove all loose and deteriorated column caulk and repair. This could be done by in-house personnel.

Leg Conditions:

The tank is supported by ten single lattice columns that attach to the sidewalls and bowl at balcony level. The columns are in good condition and appeared in alignment.

Balcony Conditions:

Disclaimer: Unless we feel that ladders and balconies are unsafe, it is our opinion that if they were built to code at the time of construction, they do not require replacement. The code changed three times in the late 1980's and early 1990's and it seems ridiculous to replace each time. However, it is our responsibility to inform you of this possible deficiency.

The exterior balcony is in fair condition. It is located on the exterior sidewalls, is 30 in. wide, with a 42 in. high hand rail. The hand rail has a kick plate at the balcony floor. The diagonal balcony posts and top rail are angle iron. The balcony acts as a sidewall stiffener. There was no evidence of bird droppings or ponding water. There is minor corrosion at the balcony-to-tank connection.

Rod Conditions:

The tank's sway rods are in good condition. Coating on the sway rods is in fair condition, with minor spots of coating failure and surface rust on the rods and turnbuckles, and on the struts between the leg columns. Because of the inaccessibility of the sway rods, exact tension could not be determined. However, based on the amount of coating loss on the rods where the rub against each other, it was evident the rods are loose.

The riser tie rods are in good condition. The tank has ten riser tie rods that extend from the leg columns to the riser with bolted ring connections. Crevice corrosion is active behind the ring.

Rod Recommendations:

Adjust the sway rods. Loose sway rods will allow the tank to move excessively, placing undue stress on the connections. The estimated cost is $3,000.

Overflow Pipe Conditions:

The tank has an 8 in. diameter overflow pipe that exits the roof knuckle, extends down along the sidewall, through the balcony, and down along a leg column to ground level. The pipe discharges to a storm drain below grade.

Hatch/Manway Conditions:

The tank has a 24 in. diameter, flip-top, round roof access hatch to the wet interior that is in good condition. The hatch has a rainproof cover consisting of a 4 in. curb, and a 2 in. lip on the cover. It was locked. The hatch was not operable, as the roof ladder prevents opening the hatch.

The tank has a 24 in. diameter access manway in the sidewall shell, and a 24 in. diameter access manway in the riser that are in good condition. The sidewall manway is not hinged, and the gasket showed no signs of leaking. The bolts have no coating.

Hatch/Manway Recommendations:

Install a 30 in. manway in the riser. Average size rescue baskets will not pass through the existing manway. The estimated cost is $7,000.

Replace the roof access hatch with a new 30 in. curbed hatch that has a 2 in. lip, 4 in. curb, and a lockable hasp. Average size rescue baskets and rescue personnel wearing equipment will not pass through the existing 24 in. hatch. The estimated cost is $3,000.

Vent Conditions:

The roof vent is a 16 in. flow-through design. The vent has a 3 in. diameter hole cut through the top plate for antenna cable. The hole is open and would allow birds to enter the wet interior. The vent is properly screened. No evidence of entry was found.

Vent Recommendations:

Weld shut the hole that was cut in the top plate of the vent. This could be done in conjunction with roof repairs.

Roof Hand Rail/Painter's Rail Conditions:

The roof has neither a roof hand rail nor a painter's rail.

Roof Hand Rail/Painter's Rail Recommendations:

Install a 25 ft. diameter, 42 in. high railing on the roof. The railing would allow tie-off locations and safety during routine vent screen and obstruction light inspections, and would also provide a work area for retrieval personnel using roof extraction. The railing should provide sufficient area to rest a basket for helicopter lift, or for stabilizing before lowering down through the riser. Install a painter's rail outside the railing so contractor rigging does not interfere with the railing's interior clear area. The estimated cost is $12,000.

Install safety grabs and rigging couplings on the exterior roof near the painter's rail for fall prevention of workers in the wet interior. The grabs would allow workers in the wet interior to be completely tied off to fall prevention at all times. Cost would be incidental to coating costs.

Antenna Conditions:

The roof area contains one antenna that is attached to the roof vent.

The balcony has three antennas attached to mounting brackets on the hand rail. The antenna cables attached to the roof vent present a potential safety and health problem.

Antenna Recommendations:

Lock the access hatch to the wet interior. Because of the antennas there will be people working on the tank on a routine basis who may not be familiar with the sanitary requirements of a potable water supply. In addition, with more people accessing the tank, the door may be inadvertently left open.

Require the antenna contractor to return and correct the cable and hygiene problems. The simple solution is to have a mounting pole welded to the roof and a plate welded over the open hole.

Pit/Pit Piping Conditions:

The tank is operated by valves located in the pit below the tank. The pit does not have an altitude valve. The owner noted there have been no problems with the valve. The rusted piping is in poor condition. Coating on the piping is also in poor condition. The pipes and valves have extensive coating failure. Some of the valves are new and do not require painting. Said valves should be protected from damage during any maintenance painting. No coating remains on the piping. Steel loss is occurring on the flanges and bolts in the pit. The pit was dry during the inspection.

Pit/Pit Piping Recommendations:

Abrasive blast clean the piping to a near white condition (SSPC-SP10), and apply two coats of epoxy. The corroded bolts should be replaced after abrasive blast cleaning. The estimated cost is $5,000.

Fill Pipe Conditions:

The 10 in. diameter fill pipe extends 1 ft. into the bottom of the riser. The top of the pipe does not have a deflector plate.

Mud Valve Conditions:

A single mud valve is located in the bottom of the riser. The valve operated properly during the inspection.

Ladder Conditions:

The tank has an exterior leg ladder that starts approximately 12 ft. above ground level, and extends up to the balcony. The ladder is in good condition, and contains a rail-type fall prevention device.

The tank has a fixed sidewall shell and revolving roof ladder. The ladder has a rail-type fall prevention device, preventing movement. The roof ladder cannot move past the roof manway and overflow weir box. The revolving roof ladder attaches around the vent pipe at the center of the roof.

The wet interior has a ladder from the sidewall manway to the bottom of the bowl. The ladder is in poor condition, and does not meet current MiOSHA size requirements. The top section has been damaged by ice. The ladder does not have a rail-type fall prevention device. There is no ladder from the roof manway to the bowl.

Ladder Recommendations:

The revolving roof sidewall shell ladder should be replaced with a vertical sidewall ladder that runs up to a step-off platform that is surrounded with hand rails at the roof hatch. The step-off platform would provide a safe working area around the roof hatch. The estimated cost is $10,000. A hand rail from the step-off platform to the roof hand rail would replace the roof ladder. Steps or cleats would be installed to increase traction. This would remove all loading from the roof vent pipe.

Install a ladder in the wet interior from the roof to the bowl. Equip with a fall prevention device. Repair the damaged section of the sidewall/bowl ladder. The estimated cost is $8,000.

Wet Interior Metal Conditions:

The steel structure is in poor condition above the high water line, and in good condition below the high water line.

The interior roof is supported by twelve radial beams that are in poor condition, with minor corrosion at the edges. Several of the roof beams are bent and broken. There are gaps in the riveted seam where the roof meets the sidewalls. There are several old bolt holes in the roof.

There is a hand rail around the riser opening.

Metal in the riser is severely pitted. The pitting occurred prior to the current coating application. The metal is being protected by the current coating. There is minor, active corrosion in the riser.

Wet Interior Metal Recommendations:

Monitor corrosion on edges of the roof beams. Recoat the roof before metal loss becomes significant.

Reweld or replace the five bent and broken roof beams. The estimated cost is $20,000. This is budgeted separately and does not include any other paint touch-ups. Plug the old bolts holes in the roof and seal the gaps in the riveted seam where the roof meets the sidewall, and where the cathodic caps on the roof have shifted. Seal weld the remaining or undamaged roof beams.

STEEL TANK FIELD INSPECTION REPORT
LEG TANK

DATE: **May 7, 2008**

I. TANK DATA

OWNER: **City of Benton Harbor**
CLIENT CODE: **22-11-05-01**
TANK NAME: **650,000 Gallon Double Ellipse (Britain Tank)**
LOCATION: City: **Benton Harbor**
State: **MI**
TANK SIZE: Capacity: **650,000 gallons**
Height to bottom (LWL): **126 feet**
CONSTRUCTION: **Welded - Riveted**
Type of Structure: **Double Ellipse**
Type of Roof: **Ellipsoid**
Type of Bowl: **Ellipsoid**
DATE CONSTRUCTED: **1962**
MANUFACTURER: **PDM**

COATING HISTORY:	EXTERIOR	WET INTERIOR	DRY INTERIOR **N/A**
DATE LAST COATED	**1990**	**1990**	
CONTRACTOR	**G&M**	**G&M**	
PAINT SYSTEM	**Polyurethane**	**3 coat epoxy polyamide**	
SURFACE PREPARATION	**SP6**	**SP10**	
PAINT MANUFACTURER	**Tnemec**	**Tnemec**	
PAINT SAMPLES	**No**	**No**	
LEAD COATING	**No**	**No**	

INSPECTED BY: **Dixon Engineering, Inc.**
INSPECTORS: **Roy Wise; Larry Houck; Eric Binkowski**
TYPE OF INSPECTION: Maintenance
DATE LAST INSPECTED: **10/16/97**

II. INSPECTION DATA

SITE CONDITIONS:

Fenced: **Yes**
Control building: **No**
Antenna control sites: **Yes**
Number: **1**
Location: **Adjacent to riser; underneath bow; city antenna**
Site condition: **Not maintained**
Neighborhood: **Residential - Retail**
Describe surroundings: **Residential north and east; body shop west**
Power lines within 50 feet: **Yes**
Other concerns: **Building (8 ft. x 8 ft.) located 6 ft. from riser; trees and limbs touching tank southeast side; fencing 6 ft. – 8 ft. from tank legs**

PIPING:

Pit: **Yes**
Location: **Adjacent to tank**
Condition of pit structure: **Fair**
SCADA controls: **No**
Controls heated: **Yes**
Altitude valve: **Yes**
Condition of coating: **Poor**
Describe coating: **Erosion - No coating remaining**
Condition of metal: **Good**
Piping comments: **Some valves are new with intact coating; older valves/pipes have scale rust on bolts and flanges**

FOUNDATION:

Riser:

Foundation exposed: **Yes**
Amount exposed: **6 inches**
Exposed foundation condition: **Good**
Chipped or cracked: **Yes**
Severity: **Minor**
Type of grout: **None**
Indications of foundation settlement: **No**
Riser comments: **Riser moved during inspection**

Legs:

Foundation exposed: **Yes**

FOUNDATION:

Amount exposed: **6 inches**
Exposed foundation condition: **Good**
Concrete chipped or cracked: **Yes**
Severity: **Minor**
Type of grout: **Caulk**
Condition: **Fair**
Grout missing: **Yes**
Amount missing: **20 ft.**
Indications of foundation settlement: **No**
Leg comments: **Delaminated coating to substrate**

Site:

Site drainage: **Towards foundation**
Indications of underground leakage: **No**
Undermining of foundation: **No**
Shrubs, trees, etc. encroachment: **No**

EXTERIOR:

Legs:

Number: **10**
Type: **Lattice**
Exterior connection to tank: **Good**
Explain: **Minimal rusting/rust staining**
Topcoat condition: **Good**
Primer/Previous coating condition: **Good**
Describe coating: **Delamination - Spot coating breaks to substrate**
Dry film thickness (DFT) of coatings: **8 - 14 mils**
Metal condition: **Good**
Leg comments: **Delaminated topcoat to prime**

Riser:

Diameter: **72 inches**
Topcoat condition: **Fair**
Primer/Previous coating condition: **Good**
Describe coating: **Delamination - Rust bleed through**
Mildew growth: **Yes**
Amount: **Light**
Dry film thickness (DFT) of coatings: **6 - 10 mils**
Metal condition: **Good**

EXTERIOR:

Riser comments: **Delaminated topcoat-to-prime; exposed steel rusting**

Tank Bowl:

Topcoat condition: **Good**
Primer/Previous coating condition: **Good**
Mildew growth: **Yes**
Amount: **Light**
Metal condition: **Good**
Riser to bowl connection: **Good**
Bowl comments: **Light algae growth**

Tank Sidewall:

Lettering: **Yes** Number: **2**
Describe the lettering: **BENTON HARBOR**
Logo: **Yes** Number: **1**
Describe the logo: **City logo with gulls**
Topcoat condition: **Fair**
Primer/Previous coating condition: **Good**
Describe coating: **Fading - Delamination - Spot coating breaks to primer**
Dry film thickness (DFT) of coatings: **8 - 13 mils**
Metal condition: **Good**
Sidewall comments: **Topcoat cracks and delamination; areas of pinhole rusting at low film build**

Tank Roof:

Topcoat condition: **Good**
Primer/Previous coating condition: **Fair**
Describe coating: **Fading - Delamination - Spot coating breaks to substrate - Rust bleed-through**
Dry film thickness (DFT) of coatings: **7 - 14 mils**
Metal condition: **Good**
Roof comments: **Rusting at spot coating breaks; coating undercoat bleed-through from coating erosion**

EXTERIOR ACCESSORIES:

Anchor Bolts:

Number bolts per leg: **2**
Diameter: **1½ inches**

EXTERIOR ACCESSORIES:

Number of riser anchor bolts: **None**
Coating condition: **Good**
Metal condition: **Good**
Anchor bolt comments: **Some rust bleed-through and corrosion with minor steel loss**

Exterior Overflow Pipe:

Coating condition: **Good**
Metal condition: **Good**
Inside diameter: **8 inches**
Condition of screen: **None in-place**
Flap gate: **No**
Air gap: **No**
Splash pad: **No**
Overflow comments: **Overflow connects to storm sewer below grade**

Riser Manway:

Coating condition: **Fair**
Metal condition: **Good**
Size: **24 in. diameter**
Gasket leaking: **No**
Hinged: **Yes**

Struts and Rods:

Number of bays: **4**
Sway rods:
- Coating condition: **Fair**
- Metal condition: **Good**

Struts:
- Coating condition: **Fair**
- Metal condition: **Good**

Riser rods:
- Coating condition: **Fair**
- Metal condition: **Good**

Sway rods, struts, rod comments: **Loose sway rods in upper bay; coating delaminated from prime coat**

Leg Ladder:

Coating condition: **Good**

EXTERIOR ACCESSORIES:

Metal condition: **Good**
Toe clearance: **7 inches**
Width of rungs: **15 inches**
Thickness of rungs: **$^{5}/_{8}$ inch**
Shape of rungs: **Round**
Fall prevention device: **Yes**
Type: **Rail**
Condition: **Good**
Cage: **No**
Step-off Platform: **No**
Leg ladder comments: **Delaminated topcoat-to-prime; surface rusting at exposed prime**

Balcony:

Balcony width: **30 inches**
Railing height: **42 inches**
Midrail: **Diagonals**
Toe plate height: **3 inches**
Coating condition: **Fair**
Describe coating: **Delamination - Spot coating breaks to substrate**
Balcony supports and connections: **Good**
Missing bolts or rivets: **No**
Number of penetrations: **11**
Penetrations reinforced: **No**
Penetration uses: **Overflow pipe - columns**
Accumulation of bird droppings: **No**
Water pooling: **No**
Metal condition: **Good**
Balcony comments: **Antenna cables/conduit; rusting along balcony toe kick**

Sidewall Ladder:

Style: **Vertical**
Coating condition: **Good**
Metal condition: **Good**
Toe clearance: **6 inches**
Width of rungs: **15 inches**
Thickness of rungs: **$^{5}/_{8}$ inch**
Shape of rungs: **Round**

EXTERIOR ACCESSORIES:

Style: **Fixed**
Fall prevention device: **Yes**
Type: **Rail**
Cage: **No**

Sidewall Hatch:

Coating condition: **Good**
Metal condition: **Good**
Size: **24 in. diameter**
Bolted: **Yes**
Hinged: **No**
Gasket leaking: **No**

Platform: N/A

Roof Ladder:

Design: **Revolving**
Coating condition: **Good**
Metal condition: **Good**
Width of rungs: **15 inches**
Shape of rungs: **Round**
Fall prevention device: **Yes**
Type: **Rail**
Condition: **Good**
Cage: **No**
Roof ladder comments: **Roof ladder over top of the wet interior roof manway restricting manway operation; ladder offset to sidewall ladder**

Roof Handrail: N/A [Proposed Diameter: 25 feet]

Roof Access Hatches:

Wet interior:
Coating condition: **Good**
Metal condition: **Good**
Opening size: **24 inches**
Shape: **Round**
Hatch security: **Unknown**
Hatch comments: **Unable to open because of roof ladder**

EXTERIOR ACCESSORIES:

Roof Vents:

Number of vents: **1**
Type: **Standard**
Neck diameter: **16 inches**
Coating condition: **Good**
Metal condition: **Good**
Screen condition: **Good**
% of screen open: **100**
Vent Comments: **3 in. diameter hole cut in top of vent for antenna cable**

Aviation Lights: N/A

Cathodic Caps:

Number: **10 - 12**
Coating condition: **Good**
Metal condition: **Good**
Aligned: **No**
Cathodic cap comments: **Caps require adjustment to close open gaps in roof**

Rigging Couplings: N/A

Antennas:

Number: **3 + 1**
Location: **Balcony (3); Roof vent (1)**
Cable runs: **Up 2 legs**
Cables interfere with climbing: **No**
Antenna comments: **Antenna on roof runs through open hole in top of vent restricting closing of hole**

WET INTERIOR:

Tank Roof:

Topcoat condition: **Good**
Primer condition: **Good**
Metal condition: **Good**
Roof to sidewall connection: **Fair**
Condition of laps: **Good**
Laps: **Open**

EXTERIOR ACCESSORIES:

Tank roof comments: **5 approximately 6 in. gaps at roof-to-sidewall connection; several old bolt holes in roof**

Tank Sidewall:

Topcoat condition: **Good**
Primer condition: **Good**
Describe coating: **Rust undercutting - no coating where steel beams removed**
Mineral deposits: **Light**
Metal condition: **Good**
Active pitting: **No**
Previous pitting: **No**
Previous pit filling: **Unknown**
Tank Sidewall comments: **Spot rusting at rivets/lap seams**

Access Tube: N/A

Tank Bottom:

Topcoat condition: **Good**
Primer condition: **Good**
Describe coating: **Spot coating breaks to substrate**
Mineral deposits: **Light**
Metal condition: **Good**
Active pitting: **No**
Previous pitting: **No**
Previous pit filling: **Unknown**
Sediment on floor: **Yes**
Depth of sediment: **¼ inch**
Tank bottom comments: **Some burn marks from cut steel; multiple pinholes and rusting throughout bowl**

Riser:

Topcoat condition: **Good**
Primer condition: **Good**
Describe coating: **Spot coating breaks to substrate**
Metal condition: **Good**
Active pitting: **Yes**
Deepest pit depth: **⅛ inch**
Number of pits: **11-25**

EXTERIOR ACCESSORIES:

Previous pitting: **Yes**

Number of pits: **More than 75**

Previous pit filling: **Unknown**

Riser comments: **Rusting at all rivet seams**

WET INTERIOR ACCESSORIES:

Tank Ladder:

Coating condition: **Good**

Metal condition: **Fair**

Toe clearance: **8 inches**

Width of rungs: **16 inches**

Thickness of rungs: **$^{5}/_{8}$ inch**

Shape of rungs: **Round**

Shape of side rails: **Flat plate**

Fall prevention device: **No**

Tank ladder comments: **Previous steel loss on rungs**

Cathodic Protection:

Clips and pressure fitting present: **Yes**

Type: **Floating ring**

Condition: **Poor**

Explain: **Wires sheared off at top of riser**

Cathodic protection comments: **Cathodic requires repair**

Fill Pipe:

Diameter: **10 inches**

Coating condition: **Good**

Metal condition: **Good**

Height above floor: **18 inches**

Deflector plate/grate/bar: **No**

Recirculation line: **No**

Fill pipe comments: **No deflector plate**

Draw Pipe: N/A - (Same as fill pipe)

Overflow:

Type: **Weir box**

Coating condition: **Fair**

Metal condition: **Good**

WET INTERIOR ACCESSORIES:

Roof Beams: Radial
Number: **12**
Shape: **Angle**
Dimensions: **3 x 4 inches**
Coating condition: **Good**
Metal condition: **Good**
Roof beam comments: **Bottom sections have been removed approximately 5 ft. and fallen into the tank; 5 beams require repair**

Sidewall Beams: N/A

Riser Safety:
Riser grate: **No**
Riser railing: **Yes**
Railing height: **42 inches**
Midrail height: **24 inches**
Toe plate height: **4 inches**
Coating condition: **Good**
Metal condition: **Good**

Siphon: N/A

Interior Balcony: N/A

Spider: N/A

Recommendations:

Coating: **Budget to abrasive blast clean the exterior or high pressure water clean and acrylic overcoat system; abrasive blast clean pit piping and paint**

Health: **Weld cathodic caps and holes in roof; relocate antennas on roof vent; weld plate over open hole**

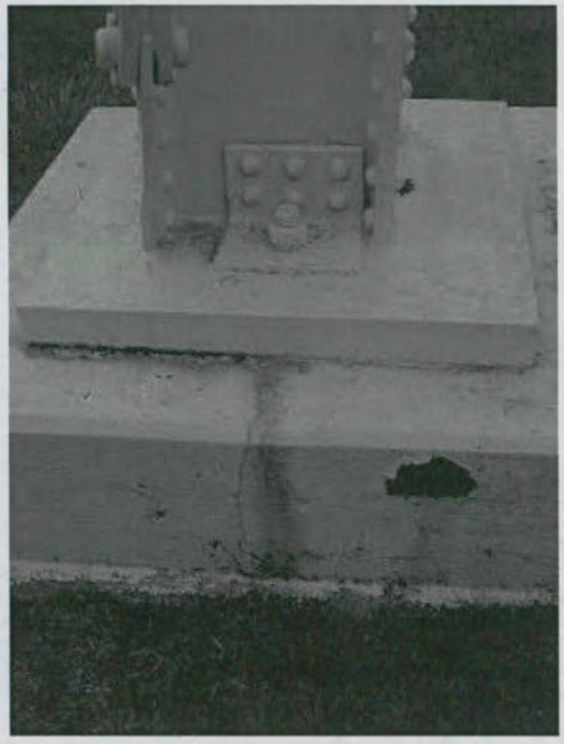
Safety: **Install exterior sidewall ladder with platform; adjust sway rods; install 30 in. manway in riser and 30 in. roof hatch; install railing and painter's rail on roof; new ladder in wet interior and on sidewall; install antenna post to roof and relocate antenna from roof vent**

Metal: **Fix and replace roof beams; repair cathodic protection; install deflector plate on fill pipe**

Field Inspection Report is prepared from the contractor's viewpoint. It contains most of the information the contractor needs to prepare his bid for any repairs or repainting. The Engineer uses it to prepare the engineering report. Cost estimates are more accurate if contractor problems can be anticipated. While prepared from the contractor's viewpoint, the only intended beneficiary is the owner. These reports are completed with diligence, but the accuracy is not guaranteed. The contractor is still advised to visit the site.



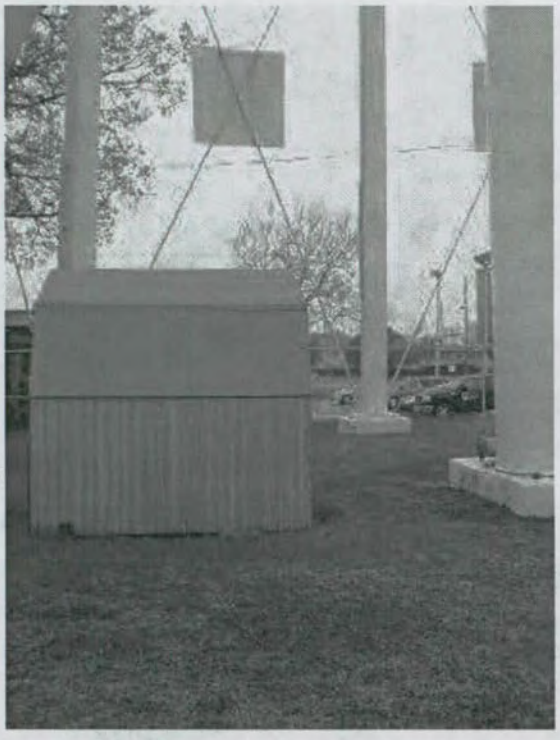
(1) Benton Harbor 650,000 gallon water storage tank.



(2) Delaminated coating on leg foundation, and missing grout beneath baseplate.



(3) Missing grouting on riser baseplate, and delaminated coating on foundation.



(4) Building with antenna control equipment next to riser.



(5) Delaminated topcoat on lattice leg.



(6) Delaminated topcoat on leg.



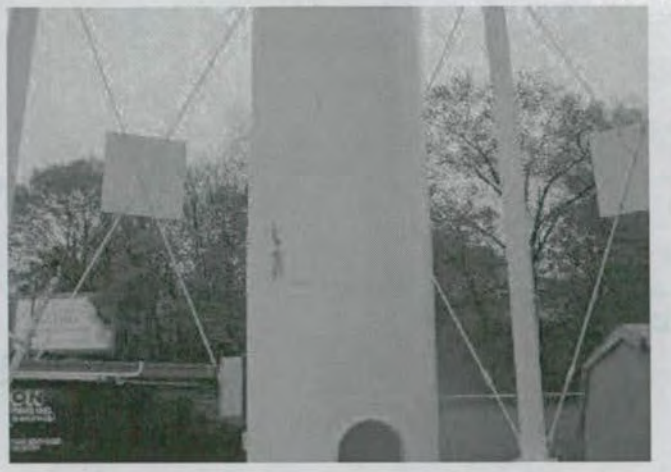
(7) Delaminated topcoat on leg and leg strut.



(8) Rust at buckles, and delaminated topcoat on strut.



(9) Delaminated topcoat on strut and leg.



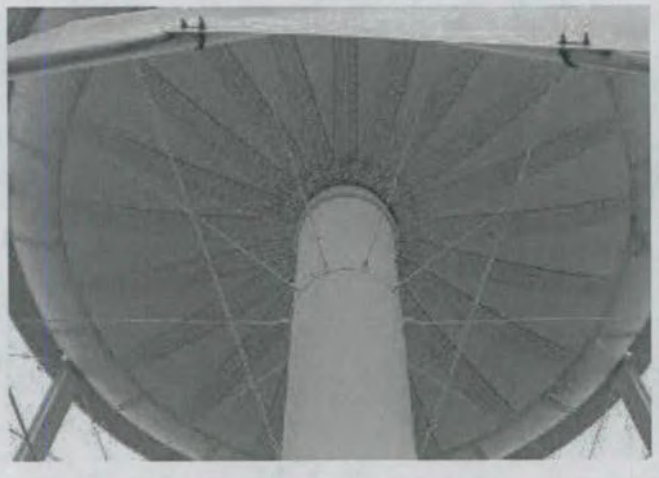
(10) Delaminated coating on riser, and rust staining.



(11) Delaminated coating on riser, and rust staining.



(12) Delaminated coating on riser, and algae on bowl.



(13) Bottom of bowl, and areas of topcoat delamination.



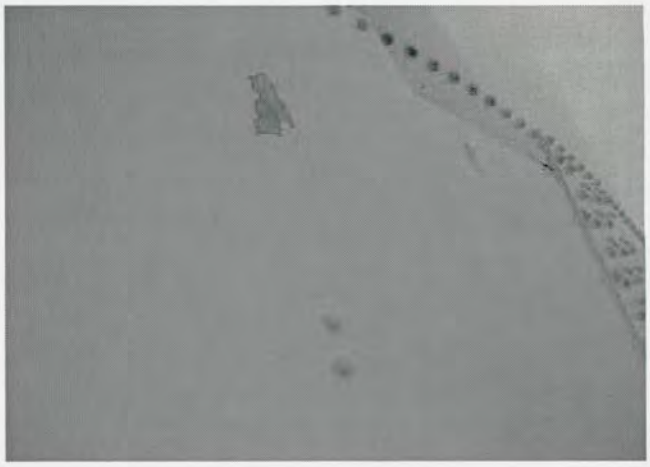
(14) Lower bowl algae stain and accumulation.



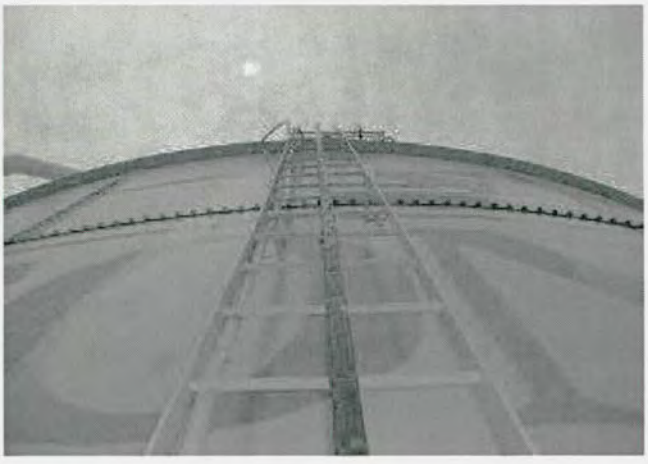
(15) Coating intact on upper bowl.



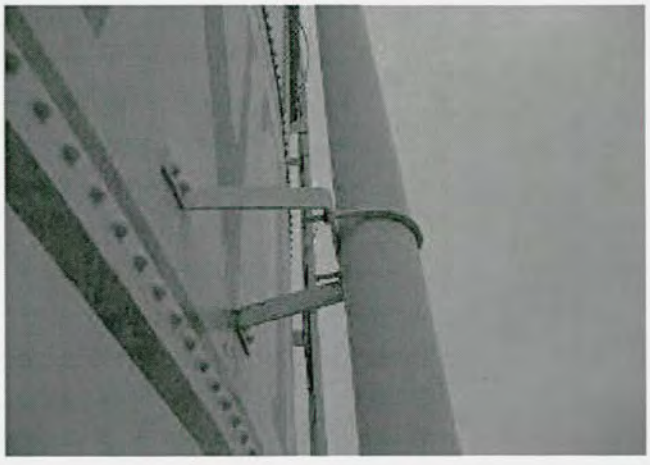
(16) Delaminated coating/rust at balcony.



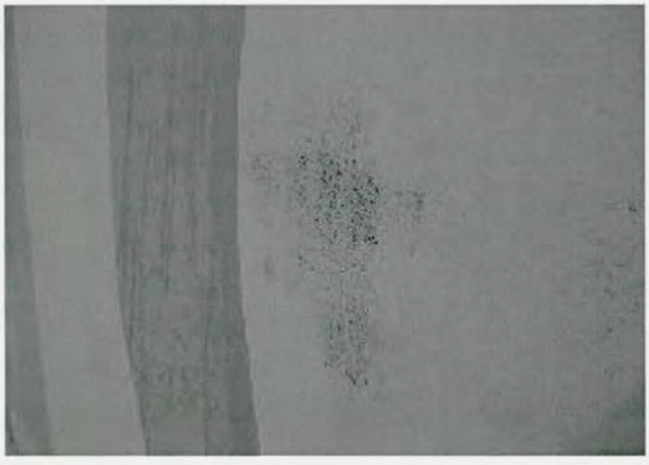
(17) Delaminated topcoat on sidewall.



(18) Sidewall ladder and pinhole rusting.



(19) Faded lettering, and overflow bracket.



(20) Pinhole rusting on sidewall.



(21) Roof coating is intact - areas of bleed-through.



(22) Exterior roof coating is intact.



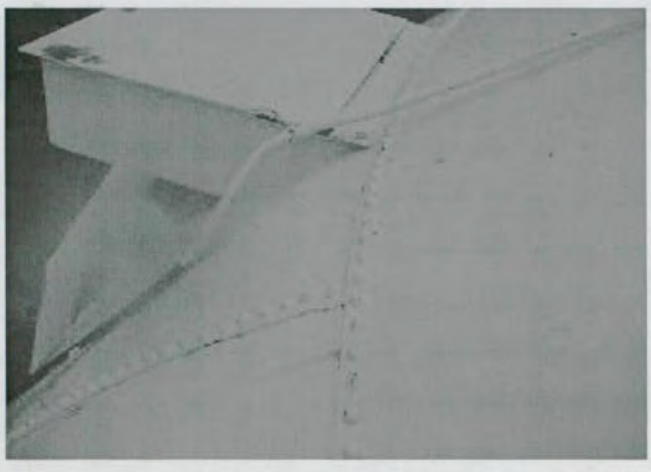
(23) Roof cathodic cap.



(24) Roof ladder over top of the roof manway.



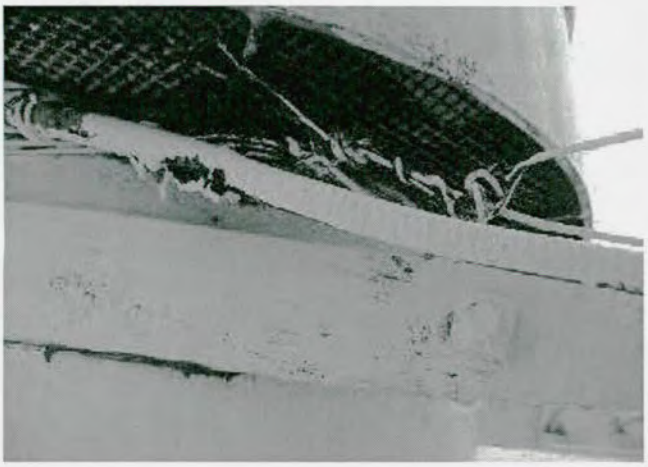
(25) Roof ladder over top of the roof manway.



(26) Overflow weir box and antenna cable showing rusting.



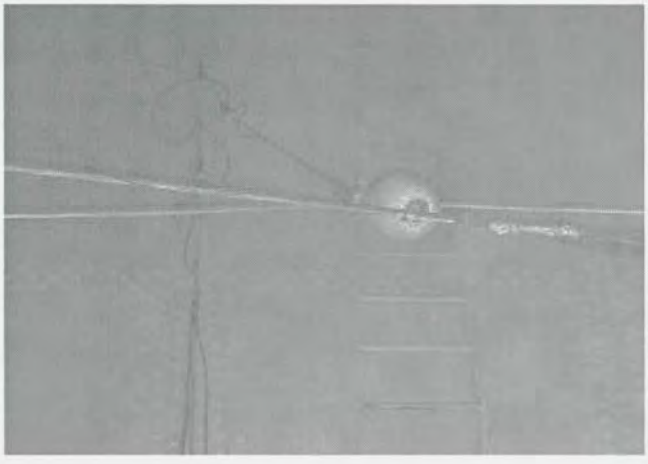
(27) Roof vent with antenna mount and open hole.



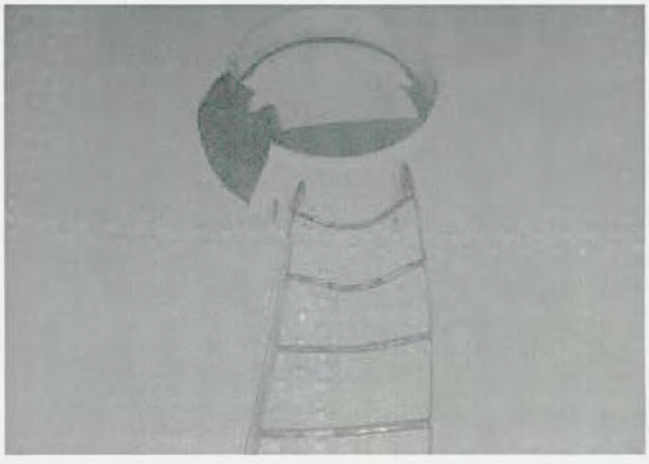
(28) Roof vent screen and antenna cable.



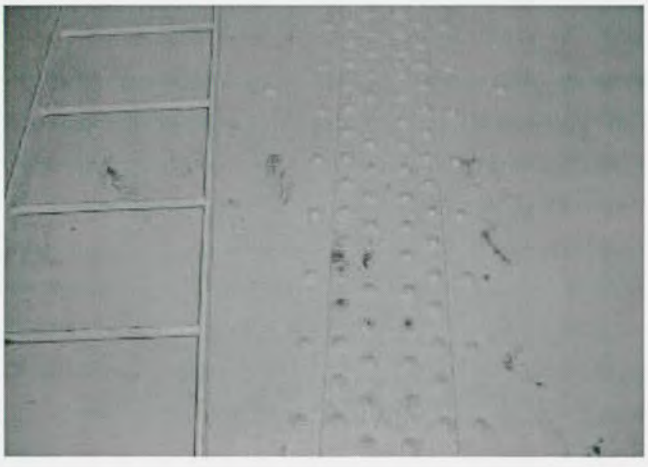
(29) Bottom of sidewall/bowl ladder.



(30) Sidewall/bowl ladder, and cathodic protection float.



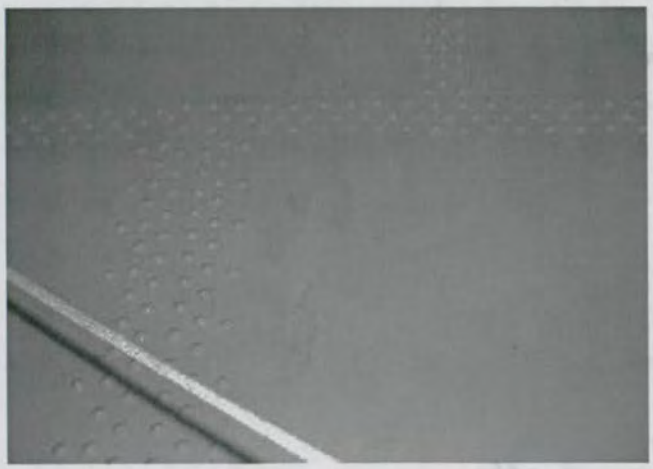
(31) Damaged 4 ft. of sidewall/bowl ladder, and torn gasket.



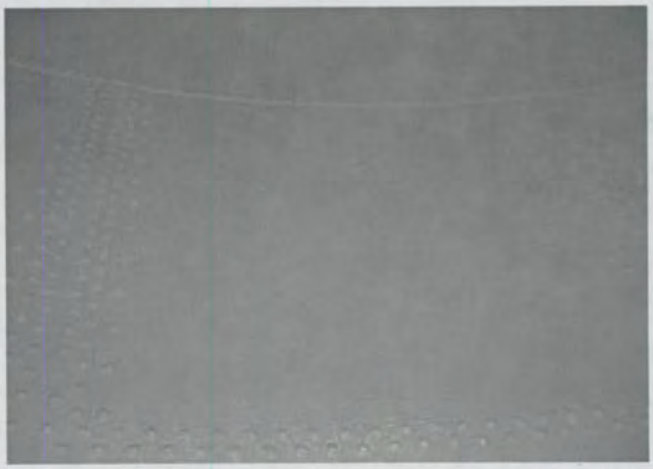
(32) Coating breaks on lower sidewall rivets.



(33) Coating break and rusting on upper bowl.



(34) Coating intact on lower sidewall.



(35) Coating intact on sidewall.



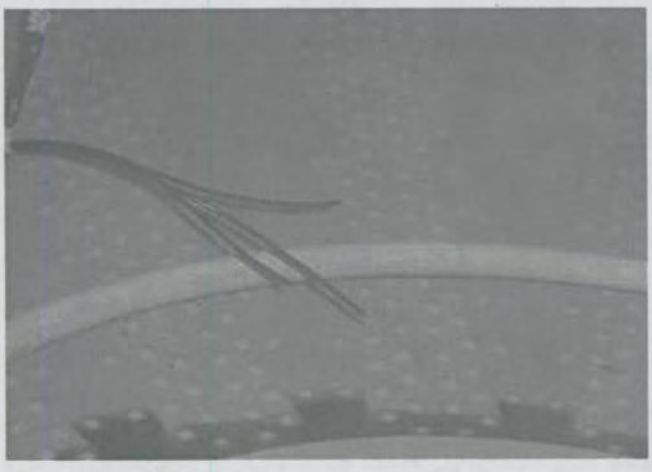
(36) Coating intact on previous pitting.



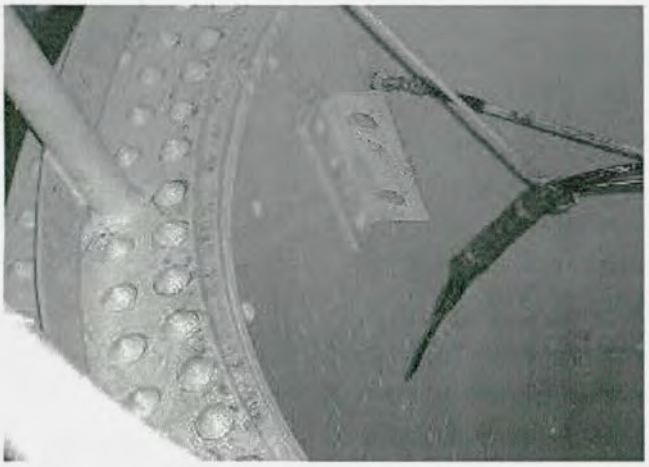
(37) Light coming through roof cathodic lift plates.



(38) Bottom of bowl, and riser railing.



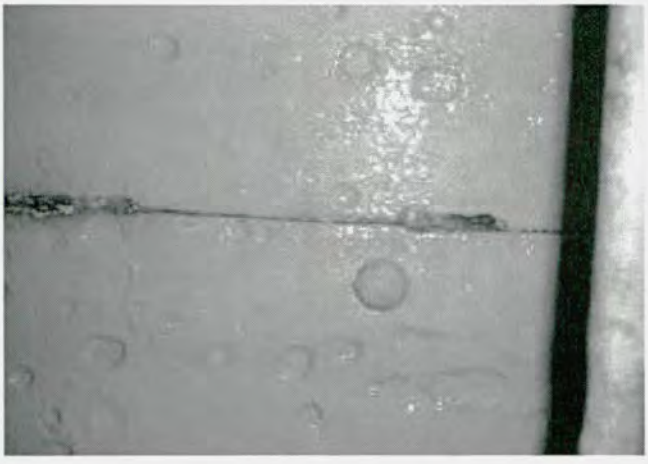
(39) Cut or sheared cathodic wires.



(40) Riser-to-bowl junction - coating protecting steel.



(41) Rust staining at riser can stitch welds.



(42) Rust staining at riser can stitch welds.



(43) Rust staining at riser can stitch welds.



(44) Rusting in area of previous pitting.



(45) Coating intact in areas of previous pitting.



(46) Fill pipe and mud valve.



(47) Riser hatch manway cover hinge.



(48) Rusted pit piping and flanges.



(49) Leg ladder fall prevention rail and vandal guard.



(50) Deformed riser ladder rung.



(51) Pit door opening and stairway.

APPENDIX D

2010, 2011, 2015, 2016 ANNUAL WATER QUALITY REPORTS

City of Benton Harbor Utility Services Department's 2010 Consumers Confidence Report

Contact Us: Michael O'Malley, Benton Harbor Water Plant (269) 927-8471
Darwin Watson, Benton Harbor Public Works/Utility Services Director (269) 927-8445
Utility Billing Payment Center (269) 934-7638
Benton Charter Township Water (269) 925-0616



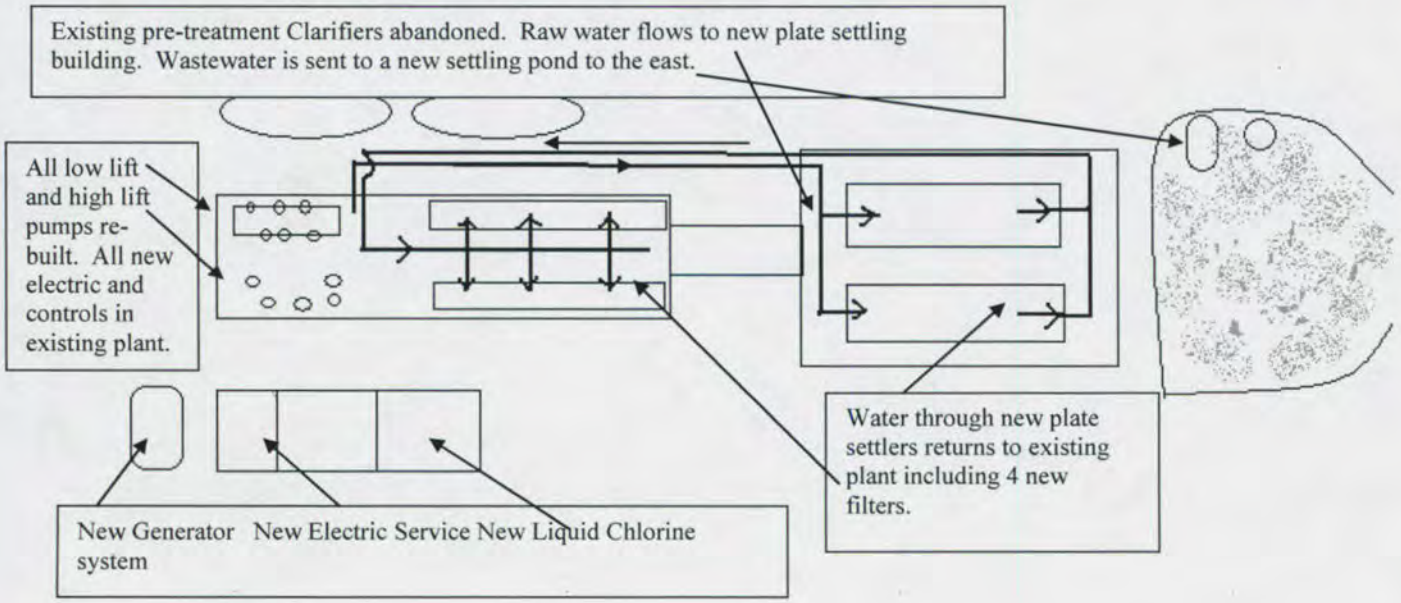
Water Plant Renovations are Nearly Complete

The Benton Harbor Water Plant is located in the southwest corner of Benton Harbor's beautiful Jean Klock Park. The Water Plant was constructed in the 1950's as a complete treatment plant that includes chemical addition for disinfection and particulate removal; mixing and settling chambers; filters; a storage reservoir; and high lift pumps to distribute the water to the City and the Townships of Benton Charter, St. Joe Charter, Hagar and Sodus. The water plant was aging and had experienced some failures. For the past 15 months the Contractor Davis Construction with several sub-contractors have been busy remodeling the existing plant and equipment and building the new treatment addition shown in the photograph. The project is nearly complete and will probably finish slightly over the $12 million budget. Funding for the project is through the State of Michigan's Drinking Water Revolving Loan Funds, which feature low interest loans to Michigan water projects. Additional funding was obtained from the Federal Government through the American Resources and Recovery Act, which will reduce the loan amount by 40%. The project is expected to be complete by October of 2011. Upon completion of the filtration plant project, the existing plant will have an anticipated life span in excess of 50 years and will offer 14 million gallons of water per day to our area users.

2010 Benton Harbor Water Quality Report

The Benton Harbor Water Plant uses Lake Michigan as its source. There are presently 5 water plants in Berrien County that use Lake Michigan as its source, including: New Buffalo, Bridgman, Lake Township and St. Joseph and the soon to be completed Benton Charter Township Water Plant. Lake Michigan is a surface water supply and is venerable to a wide range of contaminates. Because of this the EPA and MDEQ have very strict guidelines for the proper operation and testing of the water processed in these types of plants. Our Lake Michigan water is collected through a 36" pipeline that extends 4800 feet west of the water plant's shoreline. The Benton Harbor Utility Service Department's number one priority is to provide safe, high quality water to all of its customers. In pursuit of that mission, we consistently meet, and often exceed, federal and state standards for safe water.

The State MDEQ performed an assessment of our source water in 2003 to determine the susceptibility or the relative potential of contamination. The susceptibility rating is on a six-tiered scale from "very-low" to "high" based primarily on geologic sensitivity, water chemistry and contaminant sources. The susceptibility of our source is moderately high. This is due to the fact that the source water area for the Benton Harbor intake includes 1,236 potential contaminant sources, 121 listed potential contaminant sources within the susceptible area, plus urban and agricultural runoff from the St. Joseph River watershed in the St. Joseph River. A copy of the full report can be obtained by calling the water plant at (269) 927-8471.



General Health Information Provided by EPA
To ensure that tap water is safe to drink, EPA prescribes limits on the amount of certain contaminants in water provided by public water systems. FDA regulations establish limits for contaminants in bottled 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 Environmental Protection Agency's Safe Drinking Water Hotline (800-426-4791).

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and 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:

A. Microbial contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
B. Inorganic contaminants, such as salts and metals, which can be naturally-occurring or result from urban storm runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.
C. Pesticides and herbicides, which may come from a variety of sources such as agriculture, storm-water runoff, and residential uses.
D. Organic chemical contaminants, including synthetic and volatile organics, which are by-products of industrial processes and petroleum production, and can also, come from gas stations, urban storm-water runoff and septic systems.
E. Radioactive contaminants, which can be naturally occurring or the result of oil and gas production and mining activities. In order to ensure that tap water is safe to drink, EPA prescribes regulations, which limit the amount of certain contaminants in water provided by public water systems. FDA regulations establish limits for contaminants in bottled water, which must provide the same protection for public health.

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

National Primary Drinking Water Regulation Compliance
For more information about our water quality, or to receive an additional copy of this report, please contact the Water Superintendent, Michael O'Malley (269) 927-8471 or e-mail to momalley@bhcity.org.
Tours of the Water Plant are easily arranged for school or community groups by contacting the plant. For more information about safe drinking water, visit the U.S. Environmental Protection Agency (EPA) at www.epa.gov/safewater

Water Quality Detect Tables
Benton Harbor water personnel routinely monitor over 80 potential contaminants in our drinking water according to Federal and State laws. The following table lists detects of regulated contaminants found in our water for the year beginning January 1, 2010 and ending December 31, 2010, unless otherwise noted. The test results show that these contaminants were found, but are well below the drinking water guidelines.

Regulated Monitoring at the Plant

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected (RAA)	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants
Arsenic*	10*	0*	Less than 2 ppb	NA	No	9/6/10	Erosion of natural deposits; Runoff from Orchards; Runoff from glass and electronics production waste.
Nitrate (ppm)	10	N/A	ND	NA	No	9/6/10	Naturally present in the environment.
Fluoride (ppm)	4	4	1.1	1.1	No	9/6/10	Water additive, which promotes strong teeth.
Chlorine Residual	4	MRDL=4	1.51	1.23 to 1.97	No	2010	Disinfectant
TOC**	TT	N/A	1.8	1.5 to 2.0	No	2010	Naturally present in the environment
Bromodichloromethane (ppb)	80	N/A	7.5	7.5	No	9/6/10	Formed when chlorine is added to water containing naturally occurring organic material.

Chlorodibromomethane (ppb)	80	N/A	2.8	2.8	No	9/6/10	Formed when chlorine is added to water containing naturally occurring organic material.
Chloroform (ppb)	80	N/A	13	13	No	9/6/10	Formed when chlorine is added to water containing naturally occurring organic material.
Total Tri-halomethanes (ppb)	80	N/A	23.6	23.6	No	9/6/10	Formed when chlorine is added to water containing naturally occurring organic material.

**The Total Organic Carbon (TOC) was measured each quarter and the system met all TOC removal requirements set by the State of Michigan.

Regulated Monitoring Distribution System (Stage 1 Disinfection Byproduct Rule)

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected/ (RAA)	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants
TTHM (ppb)	80	N/A	54	28 to 54	NO	2010	Formed when chlorine is added to water containing naturally occurring organic material
HAA5 (ppb)	60	N/A	33	17 to 33	NO	2010	Formed when chlorine is added to water containing naturally occurring organic material

Unregulated Monitoring Distribution System (Stage 2 Disinfection Byproduct Rule) Testing in 2008-2009

Detected Substance	Benton Harbor city Samples Avg/High	Benton Twp Samples Ave/High	Range Across System	Likely Source of Contaminants. This testing is being conducted over a 12 month period to determine the vulnerability of various points in the 2 largest distribution systems served by the Benton Harbor Water Plant. Results listed are for tests run October to December 2008 only.
TTHM (ppb)	57/78	39/71	21 to 79	Formed when chlorine is added to water containing naturally occurring organic material
HAA5 (ppb)	19/21	26/35	3 to 56	Formed when chlorine is added to water containing naturally occurring organic material

TTHM's are Total Trihalomethanes and HAA5's are Haleoacetic Acids. We have completed a 1- year study of these Chlorine by-products in the City and Township distribution systems. The results will dictate what sites we will sample from in the coming years to better assure the community that the waters are properly disinfected and do not pose a threat from these by-products.

Long Term 2 (Enhanced Surface Water Treatment Rule) Testing in 2008-2009

Detected Substance	Largest Number Detected	Range of organisms detected	Likely Source of Contaminants is Lake Michigan. Lake Michigan testing is was conducted over a 24 month period that began April 2008. Testing is complete in 2009
Cryptosporidium (# of organisms)	3	0 to 3	Open Lake Michigan. Cryptosporidium are microbes found in open water sources.
E. *coli* (# of organisms)	7	1 to 82	Open Lake Michigan. E. *coli* are bacteria found in open water sources.
Giardia	3	0 to 3	Open Lake Michigan. Giardia are microbes found in open water sources.

Turbidity Monitoring at the Plant

Water Clarity	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants
Filter Effulent NTU	0.3* or no sample above 1.00	N/A	0.48 & 0.38	0.07 to 0.48	No	2010	Soil runoff.

* Turbidity is a measure of the cloudiness of the water. We monitor it because it is a good indication of the effectiveness of our filtration system. The turbidity level of the filtered water shall be less than or equal to 0.30 NTU in 95% of the samples taken each month and shall not exceed 1.0 NTU at any time.

Distribution System Monitoring Lead and Copper. Last required test date 2008.

Detected Substance	Highest Level Allowed (AL)	EPA Goal Level (AL)	90 th Percentile Detected	Range	Sites Found Above AL	Violation	Likely Source of Contaminants
Lead (ppb)	15.0	0	5	2.2 to 17	0	No	Corrosion of Household plumbing
Copper (ppb)	1300	1300	76	660 to 1.9	0	No	Corrosion of Household plumbing

The testing for lead and copper was conducted at 41 homes and completed in September of 2008. Lead and copper monitoring began in the early 1990's. Testing has been done with success every three years since 1996. The results of the 2008 test are excellent with all samples tested found to be below the action level (AL) of 15 ppb for Lead and 1300 ppb for Copper. The tri-annual testing will be done as required by September 30, 2011.

Unregulated and Special Monitoring

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Level Detected	Likely Source
Sodium	N/A	N/A	7	Naturally present in the environment
Sulfate	N/A	N/A	28	Naturally present in the environment

Definitions

MCL Maximum Contaminant Level: 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.

MCLG Maximum Contaminant Level Goal: The level of a contaminant in drinking water below, which there is no known or expected risk to health. MCLG's allow for a margin of safety.

MRDL Maximum Residual Disinfectant Level or MRDL means 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.

MRDLG Maximum residual disinfectant level goal, or MRDLG, means 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.

AL Action Level: The concentration of a contaminant, which, if exceeded, triggers treatment or other requirements, which a water system must follow.

PPM parts per million or milligrams per liter (mg/l)

PPB parts per billion, or micrograms per liter (ug/l)

NTU Nephelometric Turbidity Units, a measure of the cloudiness of water

N/A Not applicable

RAA Running Annual Average.

TT Treatment Technique: A required process intended to reduce the level of a contaminant in drinking water.

Other Water Quality Parameters of Interest

At the plant we routinely perform other water quality tests. These tests are not for official reporting, but are useful when describing the quality of our drinking water.

Parameter	2010 Average	2010 Range	Units
Chlorine, distribution	0.82	.06 to 1.45	Mg/L as free Cl-
PH	7.1	6.6to 7.7	pH units
Total Alkalinity	97.4	80 to 122	Mg/L as CaCO3
Total Hardness	145	127 to 184	Mg/L as CaCO3
Calcium Hardness	45	37 to 74	Mg/L as Ca
Magnesium Hardness	8.5	2 to 13	Mg/L as Mg
Chloride	10.5	3.1 to 17.3	Mg/L as Cl-

- For Customers owning a new dishwasher the Benton Harbor average water hardness is *8-10 grains per gallon.*

Other water testing in 2010 included full testing for synthetic and additional organic chemicals. There were no detectable levels found among any of the un-regulated contaminates tested. And no detects found among the list of the contaminates including: 2 types of Carbamates; 5 types of Chlorinated Acid Herbicides; and 20 types of Pesticides.

Other Water and Sewer Projects in and around Benton Harbor

- The MDOT Business Loop I-94 project was completed in 2010. Two years of construction to replace all water, sewer a sewer lift station and storm water infrastructure; new road and sidewalks and attractive landscaping and lighting.
- Benton Charter Township began construction of its treatment plant and distribution piping in 2010 and should be complete near September of 2011. The raw water intake and pump station is on Rocky Gap Road. The treatment plant is on North Shore Drive. Water main for distribution and separation from the City lines is complete or underway on North Shore, Paw Paw Ave, Waukonda Ave, Fair Ave, Emery St, and Donald Atkins. Projects that will begin soon include M-139, Pipestone, and Colfax Ave. The City and Benton Township water departments have worked closely together to minimize interruptions in service and the project is proceeding according to plan.
- The City of Benton Harbor Sewer Department will begin an important sewer and sewer lift station project after the summer. Some badly needed sewer lines, 3 new lift stations and quality control upgrades to the other lift stations will improve overall sewer service for the residents of Benton Harbor. Funding for this project is through the State Revolving Fund (SRF) and will be approved in early to mid October 2011.

Benton Harbor Water Plant
200 E. Wall Street
Benton Harbor, MI. 49022

PRSRT STD
ECRWSS
U.S.POSTAGE PAID
EDDM Retail

**********ECRWSS**********

Local
Postal Customer
Benton Harbor, MI. 49022

City of Benton Harbor Utility Services Department's 2011 Consumers Confidence Report

Contact Us: Michael O'Malley, Benton Harbor Water Plant (269) 927-8471
Darwin Watson, Benton Harbor Public Works/Utility Services Director (269) 927-8471
Kaye Jenkins, Utility Billing Payment Center (269) 934-7638
Tom Spitzner, Water/Sewer Superintendent, (269) 927-8471



Water Plant Renovations are Complete

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2011 Benton Harbor Water Quality Report

The Benton Harbor Water Plant uses Lake Michigan as its source. There are presently 5 water plants in Berrien County that use Lake Michigan as its source, including: New Buffalo, Bridgman, Lake Township and St. Joseph and Benton Charter Township Water Plant. Lake Michigan is a surface water supply and is venerable to a wide range of contaminates. Because of this the EPA and MDEQ have very strict guidelines for the proper operation and testing of the water processed in these types of plants. Our Lake Michigan water is collected through a 36" pipeline that extends 4800 feet west of the water plant's shoreline. The Benton Harbor Utility Service Department's number one priority is to provide safe, high quality water to all of its customers. In pursuit of that mission, we consistently meet, and often exceed, federal and state standards for safe water.

The State MDEQ performed an assessment of our source water in 2003 to determine the susceptibility or the relative potential of contamination. The susceptibility rating is on a six-tiered scale from "very-low" to "high" based primarily on geologic sensitivity, water chemistry and contaminant sources. The susceptibility of our source is moderately high. This is due to the fact that the source water area for the Benton Harbor intake includes 1,236 potential contaminant sources, 121 listed potential contaminant sources within the susceptible area, plus urban and agricultural runoff from the St. Joseph River watershed in the St. Joseph River. A copy of the full report can be obtained by calling the water plant at (269) 927-8471.

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C. Pesticides and herbicides, which may come from a variety of sources such as agriculture, storm-water runoff, and residential uses.
D. Organic chemical contaminants, including synthetic and volatile organics, which are by-products of industrial processes and petroleum production, and can also, come from gas stations, urban storm-water runoff and septic systems.
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National Primary Drinking Water Regulation Compliance

For more information about our water quality, or to receive an additional copy of this report, please contact the Water Superintendent, Michael O'Malley (269) 927-8471 or e-mail to momalley@cityofbentonharbormi.gov .

Tours of the Water Plant are easily arranged for school or community groups by contacting the plant. For more information about safe drinking water, visit the U.S. Environmental Protection Agency (EPA) at www.epa.gov/safewater

Public Notices Required in 2011

There were 3 events in the Benton Harbor Water System that required Public Notice to be made by the MDEQ.

1. A Filtered water turbidity sample that exceeded the 1 NTU rule on June 21, 2011.
2. A Coliform bacteria positive was found in the distribution system of St. Joseph Charter Township very near the border of the City of Benton Harbor on September 14, 2011.
3. The Water Department failed to sample all of the 30 lead and copper sites that have been collected over the past couple of years.

A Public notice for the turbidity event was distributed in 1 mass mailing by the end of July, 2011.

A Public notice for both the positive Coliform sample and the failure to complete all Lead & Copper sampling were combined into I notice and was distributed by mass mailing by mid-October, 2011.

Water Quality Detect Tables

Benton Harbor water personnel routinely monitor over 80 potential contaminants in our drinking water according to Federal and State laws. The following table lists detects of regulated contaminants found in our water for the year beginning January 1, 2011 and ending December 31, 2011, unless otherwise noted.

Regulated Monitoring at the Plant

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected (RAA)	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants
Arsenic	10*	0*	Less than 2 ppb	NA	No	9/6/10	Erosion of natural deposits; Runoff from Orchards; Runoff from glass and electronics production waste.
Nitrate (ppm)	10	N/A	ND	NA	No	9/27/11	Naturally present in the environment.
Fluoride (ppm)	4	4	0.78	0.78	No	9/27/11	Water additive, which promotes strong teeth.
Chlorine Residual	4	MRDL=4	2.48	0.88 to 2.48	No	2011	Disinfectant
TOC**	TT	N/A	1.94	1.78 to 1.94	No	2011	Naturally present in the environment
Bromodichloromethane (ppb)	80	N/A	7.2	7.2	No	9/27/11	Formed when chlorine is added to water containing naturally occurring organic material.
Chlorodibromomethane (ppb)	80	N/A	3.7	3.7	No	9/27/11	Formed when chlorine is added to water containing naturally occurring organic material.
Chloroform (ppb)	80	N/A	9.3	9.3	No	9/27/11	Formed when chlorine is added to water containing naturally occurring organic material.
Total Tri-halomethanes (ppb)	80	N/A	20	20	No	9/27/11	Formed when chlorine is added to water containing naturally occurring organic material.

Regulated Monitoring Distribution System (Stage 1 Disinfection Byproduct Rule)

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected/ (RAA)	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants
TTHM (ppb)	80	N/A	45	40 to 50	NO	2011	Formed when chlorine is added to water containing naturally occurring organic material
HAA5 (ppb)	60	N/A	33	22 to 39	NO	2011	Formed when chlorine is added to water containing naturally occurring organic material

Unregulated Monitoring Distribution System (Stage 2 Disinfection Byproduct Rule) Testing in 2008-2009

Detected Substance	Benton Harbor city Samples Avg/High	Benton Twp Samples Ave/High	Range Across System	Likely Source of Contaminants. This testing is being conducted over a 12 month period to determine the vulnerability of various points in the 2 largest distribution systems served by the Benton Harbor Water Plant. Results listed are for tests run October to December 2008 only.
TTHM (ppb)	57/78	39/71	21 to 79	Formed when chlorine is added to water containing naturally occurring organic material
HAA5 (ppb)	19/21	26/35	3 to 56	Formed when chlorine is added to water containing naturally occurring organic material

TTHM's are Total Trihalomethanes and HAA5's are Haleoacetic Acids. We have completed a 1- year study of these Chlorine by-products in the City and Township distribution systems. The results will dictate what sites we will sample from in the coming years to better assure the community that the waters are properly disinfected and do not pose a threat from these by-products.

Long Term 2 (Enhanced Surface Water Treatment Rule) Testing in 2008-2009

Detected Substance	Largest Number Detected	Range of organisms detected	Likely Source of Contaminants is Lake Michigan. Lake Michigan testing is was conducted over a 24 month period that began April 2008. Testing is complete in 2009
Cryptosporidium (# of organisms)	3	0 to 3	Open Lake Michigan. Cryptosporidium are microbes found in open water sources.
E. *coli* (# of organisms)	7	1 to 82	Open Lake Michigan. E. *coli* are bacteria found in open water sources.
Giardia	3	0 to 3	Open Lake Michigan. Giardia are microbes found in open water sources.

Turbidity Monitoring at the Plant

Water Clarity	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants
Filter Effulent NTU	0.3* or no sample above 1.00	N/A	1.8 & 0.33	0.07 to 1.8	Yes, 1.8 NTU	2011 Violation 6/18/11	Soil runoff.

* Turbidity is a measure of the cloudiness of the water.

On June 18, 2011, our operators measured and recorded turbidity values in excess of the MDEQ standard of no sample greater than 1 NTU. This was an unusual and isolated event and has been attributed to contamination of the sample because of construction interference. Regardless of the reason for the improper result, the Water Department issued a public notice under the guidelines of the MDEQ and has to be reported in this 2011 Consumers Confidence Report (CCR).

Distribution System Monitoring Lead and Copper. Last Official Test Date 2008. And, Tests Not complete in 2011.

Detected Substance	Highest Level Allowed (AL)	EPA Goal Level (AL)	90 th Percentile Detected	Range	Sites Found Above AL	Violation	Likely Source of Contaminants
Lead (ppb) 2008	15.0	0	5	2.2 to 17	0	No	Corrosion of Household plumbing
Copper (ppb) 2008	1300	1300	76	660 to 1.9	0	No	Corrosion of Household plumbing
Lead (ppb) 2011	15.0	0	11	0 to 22	1	No	Corrosion of Household plumbing
Copper (ppb) 2011	1300	1300	70	0 to 100	0	No	Corrosion of Household plumbing

Lead and copper monitoring began in the early 1990's. Testing was conducted in September 2011. There were not enough homes participating in the testing and the Water Department received a violation for failing to monitor at 30 sites. Notice was sent in October, 2011 and testing is required by September 30, 2012. The results of the 2011 tests are not official but are included above.

Unregulated and Special Monitoring

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Level Detected	Likely Source
Sodium	N/A	N/A	10	Naturally present in the environment
Sulfate	N/A	N/A	33	Naturally present in the environment

Definitions

MCL Maximum Contaminant Level: 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.

MCLG Maximum Contaminant Level Goal: The level of a contaminant in drinking water below, which there is no known or expected risk to health. MCLG's allow for a margin of safety.

MRDL Maximum Residual Disinfectant Level or MRDL means 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.

MRDLG Maximum residual disinfectant level goal, or MRDLG, means 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.

AL Action Level: The concentration of a contaminant, which, if exceeded, triggers treatment or other requirements, which a water system must follow.

PPM parts per million or milligrams per liter (mg/l)

PPB parts per billion, or micrograms per liter (ug/l)

NTU Nephelometric Turbidity Units, a measure of the cloudiness of water

N/A Not applicable

RAA Running Annual Average.

TT Treatment Technique: A required process intended to reduce the level of a contaminant in drinking water.

Other Water Quality Parameters of Interest

At the plant we routinely perform other water quality tests. These tests are not for official reporting, but are useful when describing the quality of our drinking water.

Parameter	2011Average	2011 Range	Units
Chlorine	1.49	.88 to 2.48	Mg/L as free Cl-
PH	7.2	6.6to 7.7	pH units
Total Alkalinity	105	90 to 135	Mg/L as CaCO3
Total Hardness	150	130 to 197	Mg/L as CaCO3
Calcium Hardness	46	18 to 61	Mg/L as Ca
Magnesium Hardness	9	3 to 16	Mg/L as Mg
Chloride	11.5	1.4 to 19.5	Mg/L as Cl-

- For Customers owning a new dishwasher the Benton Harbor average water hardness is *8-10 grains per gallon.*

2014 Benton Harbor Water Quality Report

The Benton Harbor Water Plant uses Lake Michigan as its source. There are presently 5 other water plants in Berrien County that use Lake Michigan as its source, including: New Buffalo, Bridgman, Lake Township, St. Joseph, and Benton Charter Township. Lake Michigan is a surface water supply and is vulnerable to a wide range of contaminants. Because of this the EPA and MDEQ have very strict guidelines for the proper operation and testing of the water processed in these types of plants. Our Lake Michigan water is collected through a 36" pipeline that extends 4800 feet west of the water plant's shoreline. The Benton Harbor Utility Service Department's number one priority is to provide safe, high quality water to all of its customers. In pursuit of that mission, we consistently meet, and often exceed, federal and state standards for safe water.

The State MDEQ performed an assessment of our source water in 2003 to determine the susceptibility or the relative potential of contamination. The susceptibility rating is on a six-tiered scale from "very-low" to "high" based primarily on geologic sensitivity, water chemistry, and contaminant sources. The susceptibility of our source is moderately high. This is due to the fact that the source water area for the Benton Harbor intake includes 1,236 potential contaminant sources, 121 listed potential contaminant sources within the susceptible area, plus urban and agricultural runoff from the St. Joseph River watershed in the St. Joseph River.

General Health Information Provided by EPA

To ensure that tap water is safe to drink, EPA prescribes limits on the amount of certain contaminants in water provided by public water systems. FDA regulations establish limits for contaminants in bottled 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 Environmental Protection Agency's Safe Drinking Water Hotline (800-426-4791).

The sources of drinking water (both tap water and bottled water) include rivers, lakes, streams, ponds, reservoirs, springs, and wells. As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and 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:

A. Microbial contaminants, such as viruses and bacteria, which may come from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife.
B. Inorganic contaminants, such as salts and metals, which can be naturally-occurring or result from urban storm runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.
C. Pesticides and herbicides, which may come from a variety of sources such as agriculture, storm-water runoff, and residential uses.
D. Organic chemical contaminants, including synthetic and volatile organics, which are by-products of industrial processes and petroleum production, and can also, come from gas stations, urban storm-water runoff and septic systems.
E. Radioactive contaminants, which can be naturally occurring or the result of oil and gas production and mining activities. In order to ensure that tap water is safe to drink, EPA prescribes regulations, which limit the amount of certain contaminants in water provided by public water systems. FDA regulations establish limits for contaminants in bottled water, which must provide the same protection for public health.

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

National Primary Drinking Water Regulation Compliance

For more information about our water quality, or to receive an additional copy of this report, please contact Director of Utility Services, Stewart A. Beach (269) 927-8471 or e-mail to sbeach@cityofbentonharbormi.gov (mailto:sbeach@cityofbentonharbormi.gov) .

Tours of the Water Plant are easily arranged for school or community groups by contacting the plant. For more information about safe drinking water, visit the U.S. Environmental Protection Agency (EPA) at www.epa.gov/safewater (http://www.epa.gov/safewater/)

Water Quality Detect Tables

Benton Harbor water personnel routinely monitor over 80 potential contaminants in our drinking water according to Federal and State laws. The following table lists detects of regulated contaminants found in our water for the year beginning January 1, 2014 and ending December 31, 2014, unless otherwise noted.

Regulated Monitoring at the Plant

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected (RAA)	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants

Arsenic	10*	0*	Less than 2 ppb	NA	No	9/6/10	Erosion of natural deposits; Runoff from Orchards; Runoff from glass and electronics production waste.
Nitrate (ppm)	10	N/A	1.5	ND to1.5	No	2/27/14	Naturally present in the environment.
Fluoride (ppm)	4	4	0.67	0.67	No	2/27/14	Water additive, which promotes strong teeth.
Chlorine Residual	4	MRDL=4	1.73	0.9 to 3.8	No	2014	Disinfectant
TOC	TT	N/A	1.785	1.31 to 3.83	No	2014	Naturally present in the environment

Regulated Monitoring Distribution System (Stage 1 Disinfection Byproduct Rule)

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected/ (RAA)	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants
TTHM (ppb)	80	N/A	31	25.2 to 35	NO	2014	Formed when chlorine is added to water containing naturally occurring organic material
HAA5 (ppb)	60	N/A	64	13 to 139	YES*	2014	Formed when chlorine is added to water containing naturally occurring organic material

*See "**Public Notices Required for 2014**"

TTHM's are Total Trihalomethanes and HAA5's are Haleoacetic Acids. We have completed a 1- year study of these Chlorine by-products in the City distribution system. The results will dictate what sites we will sample from in the coming years to better assure the community that the waters are properly disinfected and do not pose a threat from these by-products.

Turbidity Monitoring at the Plant

Water Clarity	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants
Filter Effluent NTU	0.3* or no sample above 1.00	N/A	.21	0.03 to 0.21	No	2014	Soil runoff.

* Turbidity is a measure of the cloudiness of the water.

Distribution System Monitoring Lead and Copper. Last Official Test Date 2012

Detected Substance	Highest Level Allowed (AL)	EPA Goal Level (AL)	90 th Percentile Detected	Range	Sites Found Above AL	Violation	Likely Source of Contaminants
Lead (ppb) 2012	15.0	0	5	0 to 38	1	No	Corrosion of Household plumbing
Copper (ppb) 2012	1300	1300	200	0 to 670	0	No	Corrosion of Household plumbing

Lead and copper monitoring began in the early 1990's. Testing was conducted in September 2012.

If present, elevated levels of lead cab 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. Benton Harbor 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 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://water.epa.gov/drink/info/lead/index.cfm (http://water.epa.gov/drink/info/lead/index.cfm)

Unregulated and Special Monitoring 2/26/2014

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Level Detected	Likely Source
Sodium	N/A	N/A	16	Naturally present in the environment
Sulfate	N/A	N/A	39	Naturally present in the environment
Chloride	N/A	N/A	34	Naturally present in the environment, storm water

Definitions

MCL	Maximum Contaminant Level: The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using th
MCLG	Maximum Contaminant Level Goal: The level of a contaminant in drinking water below, which there is no known or expected risk to health. MCLG's allow
MRDL	Maximum Residual Disinfectant Level or MRDL means the highest level of a disinfectant allowed in drinking water. There is convincing evidence that additi microbial contaminants.
MRDLG	Maximum residual disinfectant level goal, or MRDLG, means the level of a drinking water disinfectant below which there is no known or expected risk to hea disinfectants to control microbial contaminants.
AL	Action Level: The concentration of a contaminant, which, if exceeded, triggers treatment or other requirements, which a water system must follow.
PPM	parts per million or milligrams per liter (mg/l)
PPB	parts per billion, or micrograms per liter (ug/l)
NTU	Nephelometric Turbidity Units, a measure of the cloudiness of water
N/A	Not applicable
RAA	Running Annual Average.
TOC	Total Organic Carbon
TT	Treatment Technique: A required process intended to reduce the level of a contaminant in drinking water.

Public Notices Required for 2014

MONITORING VIOLATION

During the monitoring period July 1, 2014 to September 30, 2014, Benton Harbor did not collect the required number of routine samples for disinfection byproducts (TTHM and HAA5). We are required to collect these samples during the month of August. Additional samples were collected in the next monitoring period (October 1, 2014 to December 31, 2014), in the required sampling month of November, and our sampling returned to compliance. We are reviewing our monitoring schedule to ensure this does not happen again.

MCL VIOLATION

The City of Benton Harbor is required to sample for disinfection byproducts, which includes HAA5s, on a quarterly basis. The MCL for HAA5s is based on the Locational Running Annual Average (LRAA) which is the average of the past four quarter results. During May 2014, the City of Benton Harbor had a high irregular result but results since this sample have been below the MCL. Due to this irregular result, and the missed samples from the third quarter, we our running annual average for the fourth quarter 2014 was 64 ppb, which exceeds the MCL of 60 ppb. Some people who drink water containing haloacetic acids in excess of EPA's standard over many years may have an increased risk of getting cancer. The City of Benton Harbor collected additional samples, as required, on February 19, 2015, and the results have put the City of Benton Harbor back into compliance.

IMPORTANT INFORMATION ABOUT YOUR DRINKING WATER

Monitoring Requirements Not Met for City of Benton Harbor

We are required to monitor your drinking water for specific contaminants on a regular basis. Results of regular monitoring are an indicator of whether or not our drinking water meets health standards. During August 2014, we did not complete all monitoring for Total Trihalomethanes (TTHMs), and Haloacetic Acids (HAA5s); therefore, cannot be sure of the quality of our drinking water during that time.

What should I do? There is nothing you need to do at this time. This is not an emergency. You do not need to boil water or use an alternative source of water at this time.

The table below lists the contaminant we did not properly test for during August 2014, how often we are supposed to sample for this contaminant and how many samples we are supposed to take, how many samples we took, when samples should have been taken, and the date we collected follow-up samples.

Contaminant	Required sampling frequency	Number of samples taken	When all samples should have been taken	Date additional samples were (or will be) taken
TTHMs	2	0	8/1/2014 to 8/30/02014	11/1/2014 to 11/30/2014
HAA5s	2	0	8/1/2014 to 8/30/02014	11/1/2014 to 11/30/2014

What happened? What is being done? We failed to collect the necessary TTHMs and HAA5s samples for the monitoring period August 2014. Follow-up samples during the next compliance periods of November 2014 and February 2015 brought the City back into compliance. For more information, please contact: Stewart A. Beach at 269-927-8471

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

This notice is being sent to you by the City of Benton Harbor.

<!–p>Some people may be more vulnerable to contaminants in drinking water than the general population. Immune-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their healthcare providers. EPA/CDC guidelines on appropriate means to lessen the risk of infection by Cryptosporidium are available from the Safe Drinking Water Hotline (800-426-4791).

National Primary Drinking Water Regulation Compliance

For more information about our water quality, or to receive an additional copy of this report, please contact the Water Superintendent, Stewart A. Beach (269) 927-8471 or e-mail to sbeach@cityofbentonharbormi.gov (mailto:sbeach@cityofbentonharbormi.gov) .

2015 Benton Harbor Water Quality Report

This report covers the drinking water quality for Benton Harbor for the calendar year 2015. This information is a snapshot of the quality of the water that we provided to you in 2015. Included are details about where your water comes from, what it contains, and how it compares to Environmental Protection Agency (EPA) and state standards. To receive a paper copy in the mail, contact Jay Ouzts at F&V Operations (616) 588-2900 or Darwin Watson, Benton Harbor City Manager (269) 927-8400.

We invite public participation in decisions that affect drinking water quality. Meetings are held on the 1st and 3rd Monday of each month in the Lula Lee Commission Chambers, 200 E. Wall Street, Benton Harbor. For more information about your water, or the contents of this report, contact Jay Ouzts at F&V Operations (616) 588-2900 or Darwin Watson, Benton Harbor City Manager (269) 927-8400.

The Benton Harbor Water Plant uses Lake Michigan as its source. There are presently 5 other water plants in Berrien County that use Lake Michigan as its source, including: New Buffalo, Bridgman, Lake Township, St. Joseph, and Benton Charter Township. Lake Michigan is a surface water supply and is vulnerable to a wide range of contaminants. Because of this the EPA and MDEQ have very strict guidelines for the proper operation and testing of the water processed in these types of plants. Our Lake Michigan water is collected through a 36" pipeline that extends 4800 feet west of the water plant's shoreline. The Benton Harbor Utility Service Department's number one priority is to provide safe, high quality water to all of its customers. In pursuit of that mission, we consistently meet, and often exceed, federal and state standards for safe water.

The State DEQ performed an assessment of our source water in 2003 to determine the susceptibility or the relative potential of contamination. The susceptibility rating is on a six-tiered scale from "very-low" to "high" based primarily on geologic sensitivity, water chemistry, and contaminant sources. The susceptibility of our source is moderately high. This is due to the fact that the source water area for the Benton Harbor intake includes 1,236 potential contaminant sources, 121 listed potential contaminant sources within the susceptible area, plus urban and agricultural runoff from the St. Joseph River watershed in the St. Joseph River. For additional information, or to obtain a copy of the source water study, please contact Jay Ouzts at F&V Operations (616) 588-2900 or Darwin Watson, Benton Harbor City Manager (269) 927-8400.

General Health Information Provided by EPA

To ensure that tap water is safe to drink, EPA prescribes limits on the amount of certain contaminants in water provided by public water systems. FDA regulations establish limits for contaminants in bottled 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 Environmental Protection Agency's Safe Drinking Water Hotline (800-426-4791).

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B. Inorganic contaminants, such as salts and metals, which can be naturally-occurring or result from urban storm runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming.
C. Pesticides and herbicides, which may come from a variety of sources such as agriculture, storm-water runoff, and residential uses.
D. Organic chemical contaminants, including synthetic and volatile organics, which are by-products of industrial processes and petroleum production, and can also, come from gas stations, urban storm-water runoff and septic systems.
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National Primary Drinking Water Regulation Compliance
For more information about our water quality, or to receive an additional copy of this report, please contact Jay Ouzts at F&V Operations (616) 588-2900 or Darwin Watson, Benton Harbor City Manager (269) 927-8400.
Tours of the Water Plant are easily arranged for school or community groups by contacting the plant. For more information about safe drinking water, visit the U.S. Environmental Protection Agency (EPA) at www.epa.gov/safewater

Public Notices Required for 2015
Testing data from 2015 resulted in no public notices.

Water Quality Data Tables
Benton Harbor water personnel routinely monitor over 80 potential contaminants in our drinking water according to Federal and State laws. The following table lists regulated contaminants detected in our water for the year beginning January 1, 2015 and ending December 31, 2015, unless otherwise noted.

Definitions

MCL	Maximum Contaminant Level: 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.
MCLG	Maximum Contaminant Level Goal: The level of a contaminant in drinking water below, which there is no known or expected risk to health. MCLG's allow for a margin of safety.
MRDL	Maximum Residual Disinfectant Level or MRDL means 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.
MRDLG	Maximum residual disinfectant level goal, or MRDLG, means 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.
AL	Action Level: The concentration of a contaminant, which, if exceeded, triggers treatment or other requirements, which a water system must follow.
PPM	parts per million or milligrams per liter (mg/l)
PPB	parts per billion, or micrograms per liter (ug/l)
NTU	Nephelometric Turbidity Units, a measure of the cloudiness of water
N/A	Not applicable
RAA	Running Annual Average.
TOC	Total Organic Carbon
TT	Treatment Technique: A required process intended to reduce the level of a contaminant in drinking water.

Regulated Monitoring at the Plant

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected (RAA)	Range	Violation Yes, or No	Date of Sample	Likely Source of Contaminants
Fluoride (ppm)	4	4	0.15	N/A	No	2015	Water additive, which promotes strong teeth.
Chlorine Residual (ppm)	4	MRDL=4	1.38	0.64 to 2.16	No	2015	Disinfectant
TOC (ppm)	TT	N/A	2.11	0.79 to 2.11	No	2015	Naturally present in the environment
Bromodichloromethane (ppb)	80	N/A	7.2	ND to 7.2	No	2015	Formed when chlorine is added to water containing naturally occurring organic material.
Chlorodibromomethane (ppb)	80	N/A	2.9	ND to 2.9	No	2015	Formed when chlorine is added to water containing naturally occurring organic material.
Chloroform (ppb)	80	N/A	11.0	ND to 11.0	No	2015	Formed when chlorine is added to water containing naturally occurring organic material.

Total Trihalomethanes (ppb)	80	N/A	21.0	ND to 21.0	No	2015	Formed when chlorine is added to water containing naturally occurring organic material.

Regulated Monitoring Distribution System (Disinfection Byproduct)

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level (RAA)	Lowest-Highest Level Detected/	Violation Yes or No	Date of Sample	Likely Source of Contaminants
TTHM (ppb)	80	N/A	37	22.7 to 60.0	NO	2015	Formed when chlorine is added to water containing naturally occurring organic material
HAA5 (ppb)	60	N/A	56	10 to 17	NO	2015	Formed when chlorine is added to water containing naturally occurring organic material

Turbidity Monitoring at the Plant

Water Clarity	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants
Filter Effluent NTU	0.3* or no sample above 1.00	N/A	0.25	0.03 to 0.25	No	2015	Soil runoff.

* Turbidity is a measure of the cloudiness of the water.

Distribution System Monitoring Lead and Copper. Last Official Test Date 2015.

Detected Substance	Highest Level Allowed (AL)	EPA Goal Level (AL)	90th Percentile Detected	Range	Sites Found Above AL	Violation	Likely Source of Contaminants
Lead (ppb) 2015	15.0	0	12	0 to 38	2	No	Corrosion of Household plumbing
Copper (ppb) 2015	1300	1300	0	0 to 670	0	No	Corrosion of Household plumbing

Lead and copper monitoring began in the early 1990's. Testing was conducted in September 2015.

** Additional Information for 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. Andrews University 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 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.

Unregulated and Special Monitoring 2/26/2015

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Level Detected	Likely Source
Sodium	N/A	N/A	8	Naturally present in the environment
Sulfate	N/A	N/A	23	Naturally present in the environment
Chloride	N/A	N/A	12	Naturally present in the environment, storm water

A Notice to our Benton Harbor Drinking Water Community.

Please note that the following required lead language was missing from our 2016 Consumer Confidence Report:

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. Benton Harbor 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 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.

We apologize for this omission. A copy of the full report is available on our website at www.BentonHarborCity.com Follow the links on the opening page to the Water Page and the Updated Consumers Confidence Report. If you would like a copy you can request a paper copy by contacting The Benton Harbor Water Plant (269) 927-8471-2 or the Water Payment Center at (269) 927-8400-2. We are open weekdays 8:30 am to 5:00 pm.

The limits have not changed from 15ppb for Lead and 1300ppb for Copper but the focus on Lead in drinking has increased dramatically. Benton Harbor and nearly all Cities in Michigan are working very hard to protect the City water supply and our residents.

The lead sampling shown in the table of the report indicates that Lead is at very low or non-existent levels at most homes, but any Lead is still our focus to eliminate.

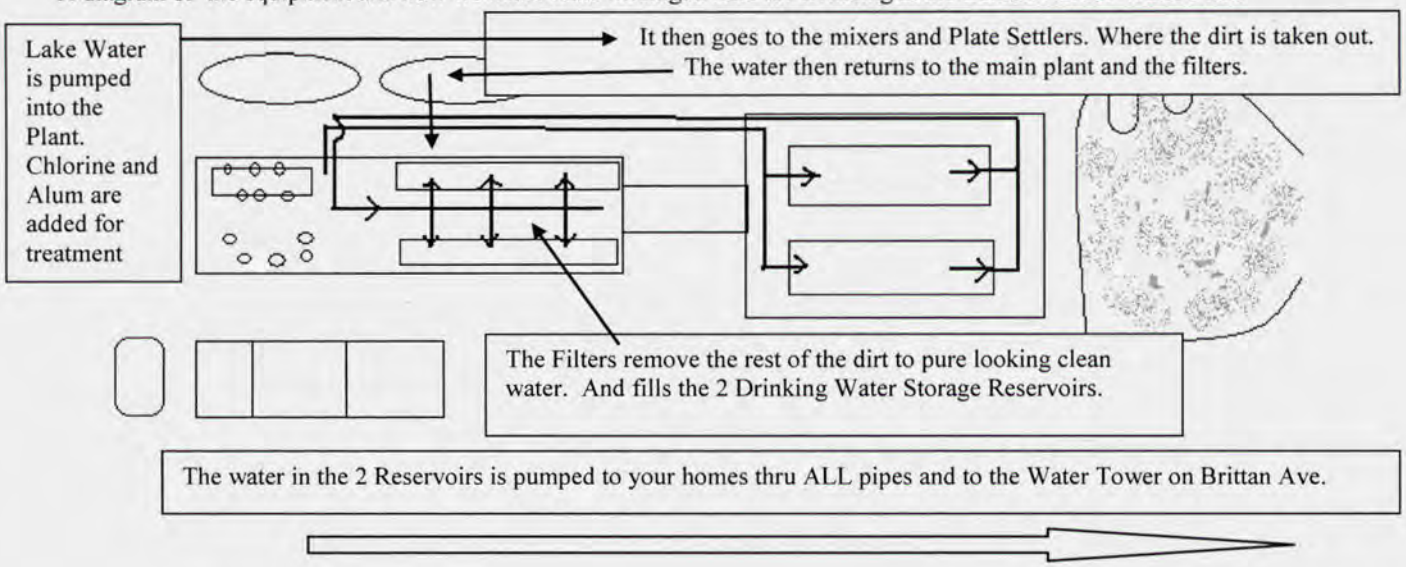
As stated above in the required MDEQ language, PLEASE, ALWAYS LET YOUR WATER RUN TILL COOL BEFORE YOU TAKE A DRINK. BE SURE TO TEACH YOUR CHILDREN AND GRANDCHILDREN TO DO THE SAME!

AND NOW OUR REVISED 2016 CCR

City of Benton Harbor Utility Services Department's 2016 Consumers Confidence Report

Contact Us: Michael O'Malley, Benton Harbor Water Plant (269) 927-8471
Darwin Watson, Benton Harbor City Manager (269) 927-
Kaye Jenkins, Utility Billing Payment Center (269) 934-7638

A diagram of the equipment and how we make Lake Michigan Safe for Drinking at the Benton Harbor Water Plant



2016 Benton Harbor Water Quality Report

The Benton Harbor Water Plant uses Lake Michigan as its source. There are presently 5 water plants in Berrien County that use Lake Michigan as its source, including: New Buffalo, Bridgman, Lake Township, St. Joseph, and Benton Charter Township Water Plant. Lake Michigan is a surface water supply and is vulnerable to a wide range of contaminates. Because of this the EPA and MDEQ have very strict guidelines for the proper operation and testing of the water processed in these types of plants. Our Lake Michigan water is collected through a 36" pipeline that extends 4800 feet west of the water plant's shoreline. The Benton Harbor Utility Service Department's number one priority is to provide safe, high quality water to all of its customers. In pursuit of that mission, we consistently meet, and often exceed, federal and state standards for safe water.

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

National Primary Drinking Water Regulation Compliance

For more information about our water quality, or to receive an additional copy of this report, please contact the Water Superintendent, Michael O'Malley (269) 927-8471 or e-mail to momalley@cityofbentonharbormi.gov .

Tours of the Water Plant are easily arranged for school or community groups by contacting the plant. For more information about safe drinking water, visit the U.S. Environmental Protection Agency (EPA) at www.epa.gov/safewater

Public Notices Required in 2016

There was one (1) event in the Benton Harbor Water System that required Public Notice to be made to you by MDEQ rules. The notice was a testing violation where, the water was not tested for Disinfection by Products in February of 2016 on the appropriate day, as was required.

Water Quality Detect Tables

Benton Harbor water personnel routinely monitor over 80 potential contaminants in our drinking water according to Federal and State laws. The following table lists detects of regulated contaminants found in our water for the year beginning January 1, 2016 and ending December 31, 2016, unless otherwise noted. Other contaminates are required as regulated monitoring, that the Water Plant

Test results in the next few tables are tests that our Water Plant personnel cannot do. These are sampled and sent to the MDEQ laboratory in Lansing and listed in the tables with various dates assigned. The last table in this report are tests routinely done at the water plant.

Regulated Monitoring at the Plant Done at the MDEQ Laboratory in Lansing, MI.

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected (RAA)	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants
Arsenic◥	10*	0*	Less than 2 ppb	NA	No	9/6/10	Erosion of natural deposits; Runoff from Orchards; Runoff from glass and electronics production waste.
Nitrate (ppm)	10	N/A	0.5	0.4 to 0.5	No	9/30/16& 11/21/16	Naturally present in the environment.
Fluoride (ppm)	4	4	0.78	0.6 to 0.78	No	9/30/16& 11/21/16	Water additive, which promotes strong teeth.
Chlorine Residual	4	MRDL=4	1.86	1.37 to 3.14	No	2016	Disinfectant
TOC**	TT	N/A	1.97	1.35 to 1.97	No	2016	Naturally present in the environment
Bromodichloromethane (ppb)	80	N/A	11	11	No	9/30/16	Formed when chlorine is added to water containing naturally occurring organic material.
Chlorodibromomethane (ppb)	80	N/A	4.8	4.8	No	9/30/16	Formed when chlorine is added to water containing naturally occurring organic material.
Chloroform (ppb)	80	N/A	18	18	No	9/30/16	Formed when chlorine is added to water containing naturally occurring organic material.
Total Tri-halomethanes (ppb)	80	N/A		34	No	9/30/16	Formed when chlorine is added to water containing naturally occurring organic material.

Regulated Monitoring Distribution System (Stage 2 Disinfection Byproduct Rule) Testing in 2016

Detected Substance	LRRA is locational Running Annual Average	Benton Harbor city Samples LRRA Site 1	Benton Harbor city Samples LRRA Site 2	Likely Source of Contaminants. This testing is being conducted over a 12 month period to determine the vulnerability of various points in the 2 largest distribution systems served by the Benton Harbor Water Plant. Results listed are for tests run October to December 2008 only
TTHM (ppb)	Each site is measured in ppb	**51.5**	**48.1**	Formed when chlorine is added to water containing naturally occurring organic material
HAA5 (ppb)	19/21 Each site is measured in ppb	**14.5**	**12.0**	Formed when chlorine is added to water containing naturally occurring organic material

TTHM's are Total Trihalomethanes and HAA5's are Haleoacetic Acids. They form when Chlorine is in contact with organic matter over time. The results are averaged at each location as a running annual average (LRAA) to assure the community that the waters are properly disinfected and do not pose a threat from these by-products.

Long Term 2 (Enhanced Surface Water Treatment Rule) Testing in 2008-2009

Detected Substance	Largest Number Detected	Range of organisms detected	Likely Source of Contaminants is Lake Michigan. Lake Michigan testing is was conducted over a 24 month period that began April 2008. Testing is complete in 2009
Cryptosporidium (# of organisms)	3	0 to 3	Open Lake Michigan. Cryptosporidium are microbes found in open water sources.
E. *coli* (# of organisms)	7	1 to 82	Open Lake Michigan. E. *coli* are bacteria found in open water sources.
Giardia	3	0 to 3	Open Lake Michigan. Giardia are microbes found in open water sources.

Turbidity Monitoring at the Plant

Water Clarity	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Highest Level Detected	Range	Violation Yes or No	Date of Sample	Likely Source of Contaminants
Filter Effulent NTU	0.3* or no sample above 1.00	N/A	1.8 & 0.33	0.07 to 1.8	Yes, 1.8 NTU	2011 Violation 6/18/11	Soil runoff.

* Turbidity is a measure of the cloudiness of the water.

Distribution System Monitoring Lead and Copper. Last Official Test Date 2008. And, Tests Not complete in 2011.

Detected Substance	Highest Level Allowed (AL)	EPA Goal Level (AL)	90 th Percentile Result Detected	Range	Sites Found Above AL of 15 ppb.	Violation	Likely Source of Contaminants
Lead (ppb)	15.0	0	12	0 to 38	2	No	Corrosion of Household plumbing
Copper (ppb)	1300	1300	0	0 to 670	0	No	Corrosion of Household plumbing

Lead and copper monitoring began in the early 1990's. The 9th round of Benton Harbor testing was conducted in September 2015. The 2 sites above the EPA action level were more than 12 ppb and one at 38 ppb. All homes on the list of sites are notified of their results and the site with 38 ppb had their water line replaced with copper. The next round of testing #10 is due in 2018.

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. Benton Harbor 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 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.

Unregulated and Special Monitoring

Detected Substance	Highest Level Allowed (MCL)	EPA Goal Level (MCLG)	Level Detected	Likely Source
Sodium	N/A	N/A	17	Naturally present in the environment
Sulfate	N/A	N/A	29	Naturally present in the environment
Fluoride	2 Secondary and 4 Primary	N/A	0.6	Water Additive to help protect teeth from Dental Caries and for Public Health

A sample was taken at the Water Plant on September 9, 2016. A laboratory in South Bend analyzed it for total Cyanide and did not detect any. Cyanide is a dangerous chemical and the EPA is determining how it may be monitored in water systems in the future.

Definitions

MCL Maximum Contaminant Level: 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.

MCLG Maximum Contaminant Level Goal: The level of a contaminant in drinking water below, which there is no known or expected risk to health. MCLG's allow for a margin of safety.

MRDL Maximum Residual Disinfectant Level or MRDL means 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.

MRDLG Maximum residual disinfectant level goal, or MRDLG, means 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.

AL Action Level: The concentration of a contaminant, which, if exceeded, triggers treatment or other requirements, which a water system must follow.

PPM parts per million or milligrams per liter (mg/l)

PPB parts per billion, or micrograms per liter (ug/l)

NTU Nephelometric Turbidity Units, a measure of the cloudiness of water

N/A Not applicable

RAA Running Annual Average.

LRAA Locational Running Annual Average.

TT Treatment Technique: A required process intended to reduce the level of a contaminant in drinking water.

Other Water Quality Parameters of Interest

At the plant we routinely perform other water quality tests. These tests are not for official reporting, but are useful when describing the quality of our drinking water.

Parameter	2016Average	2016 Range	Units
Chlorine	1.86	1.37 to 3.14	Mg/L as free Cl-
PH	7.67	7.3to 8.2	pH units
Total Alkalinity	105	93 to 133	Mg/L as CaCO3
Total Hardness	166	112 to 208	Mg/L as CaCO3
Calcium Hardness	48	30 to 67	Mg/L as Ca
Magnesium Hardness	11	2 to 18	Mg/L as Mg
Chloride	26.1	22.5 to 32.5	Mg/L as Cl-
Fluoride as F-ion	0.73	0.23 to 1.07	Mg/L as F-ion

- For Customers owning a new dishwasher the Benton Harbor average water hardness is *8-10 grains per gallon.*

APPENDIX E

SYSTEM ANALYSIS MAPS

Water Main Age

Remaining Useful Life

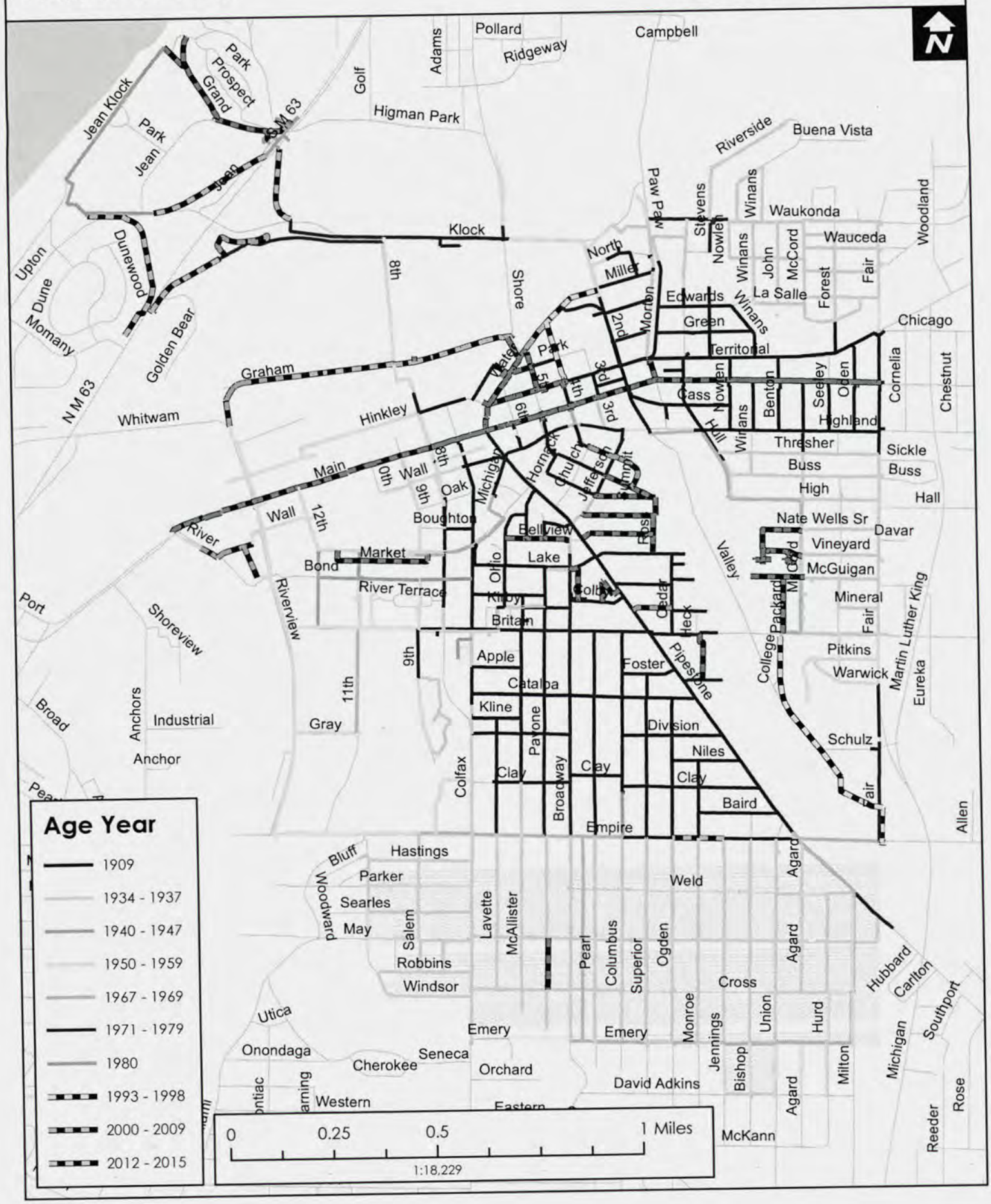
Probability of Failure

Consequence of Failure

Business Risk Evaluation Scores

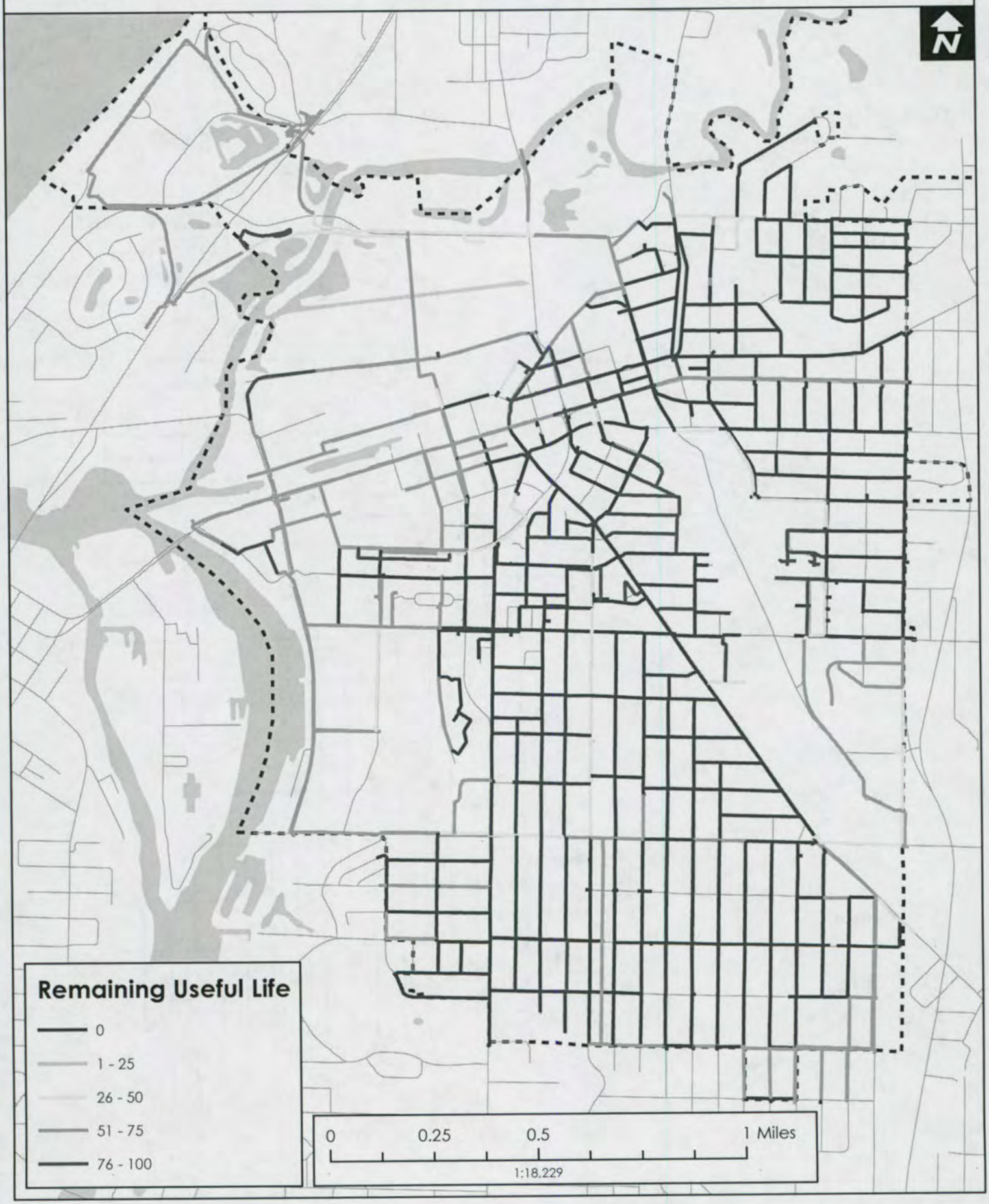
Water Mains

Benton Harbor, MI



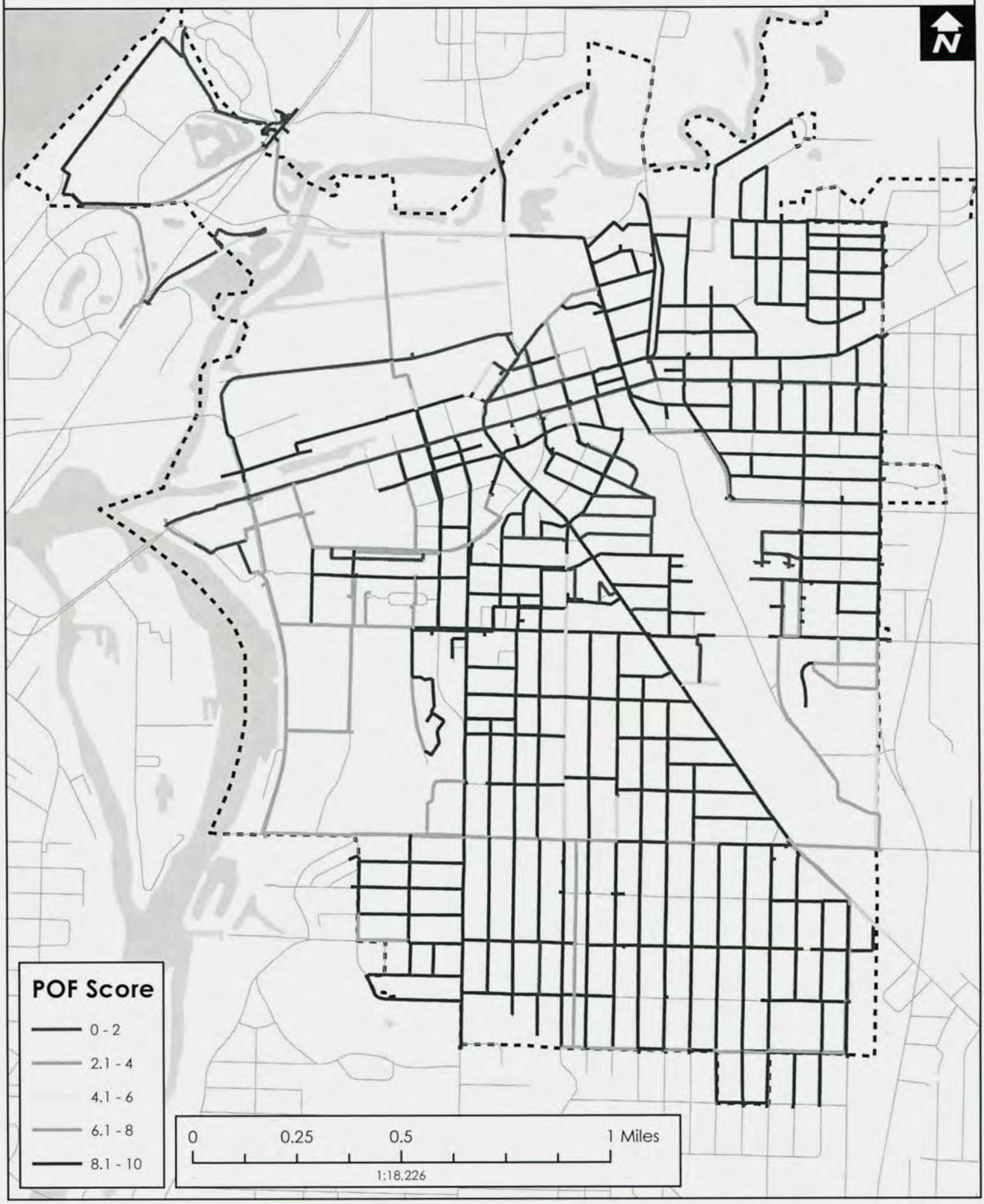
Water Mains

Benton Harbor, MI



Water Mains

Benton Harbor, MI



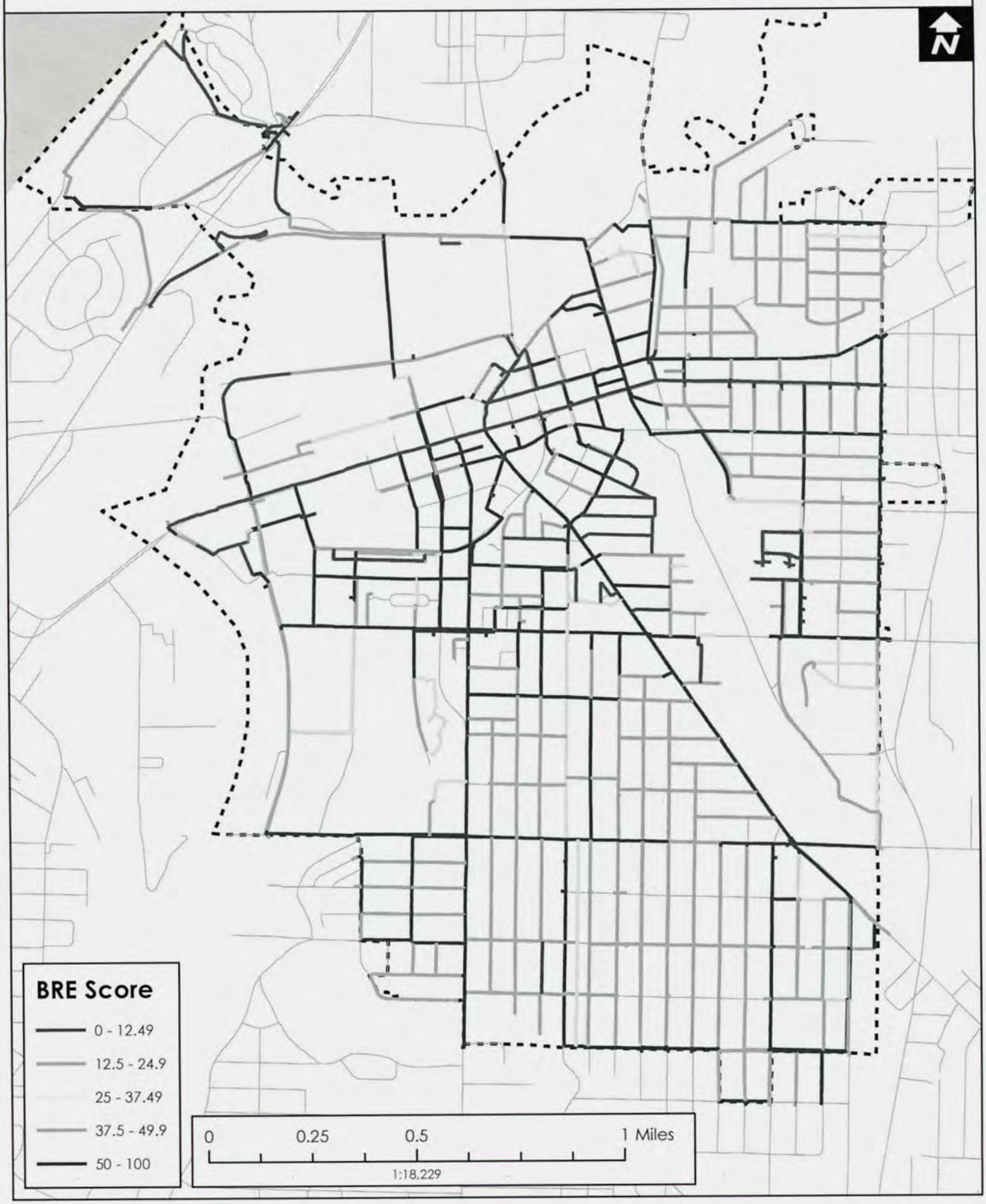
Water Mains

Benton Harbor, MI



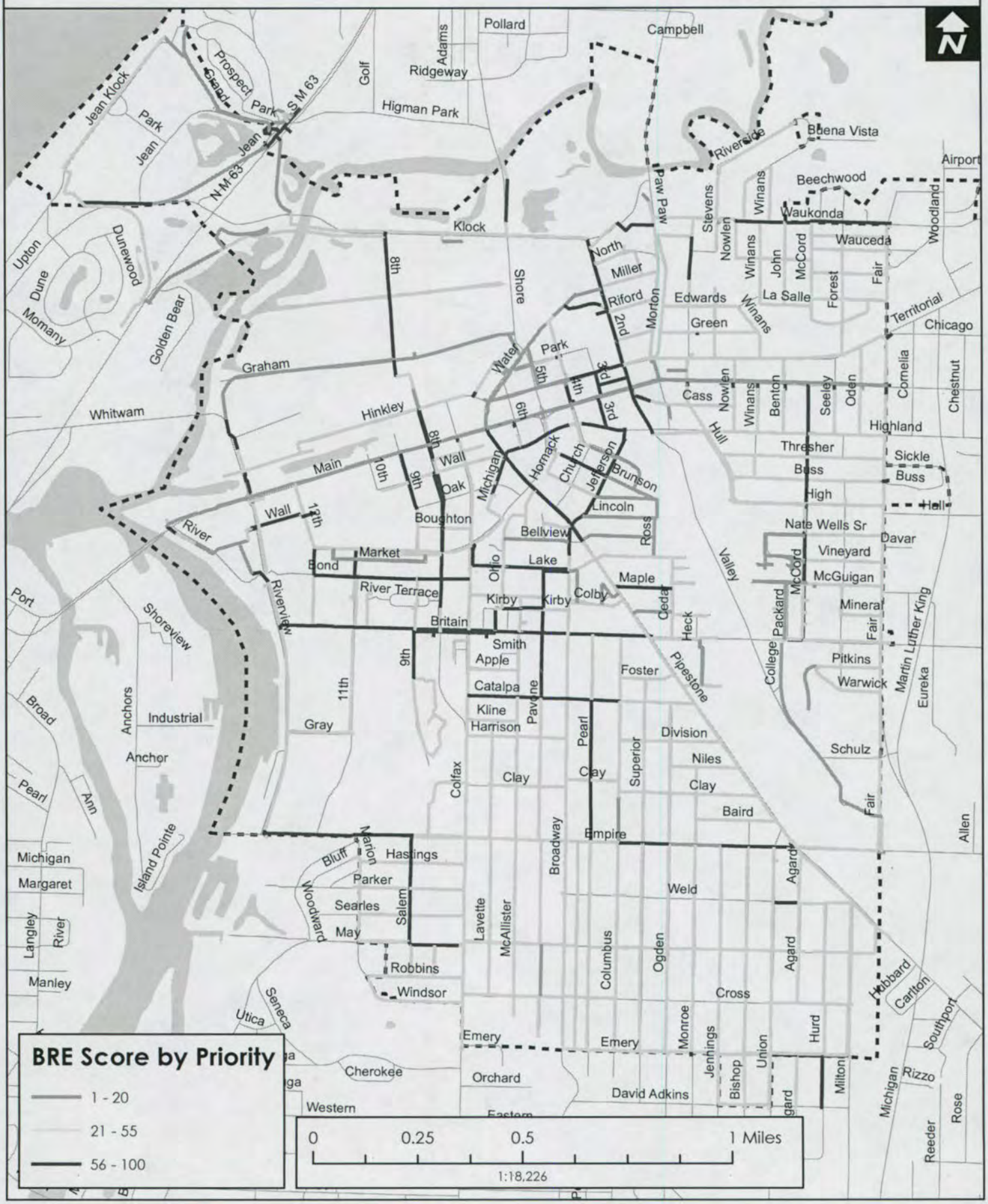
Water Mains

Benton Harbor, MI



Water Mains

Benton Harbor, MI


N
Pollard
Campbell
Adams
Ridgeway
Golf
Prospect
Grand
Park
S M 63
Jean Klock
Park
Jean
N M 63
Higman Park
Riverside
Buena Vista
Airport
Beechwood
Waukonda
Woodland
Wauceda
Klock
Upton
Dune
Momany
Dunewood
Golden Bear
Graham
Whitwam
Hinkley
Main
River
Wall
Boughton
Market
Bond
River Terrace
Riverview
Port
Shoreview
Broad
Anchors
Industrial
Anchor
Pearl
Ann
Island Pointe
Michigan
Margaret
Langley
River
Manley
Utica
Seneca
Cherokee
Western
Eastern
Orchard
Emery
Windsor
Robbins
May
Searles
Parker
Bluff
Hastings
Marion
Woodward
Salem
Gray
Britain
Smith
Apple
Catalpa
Kline
Harrison
Foster
Pipestone
Heck
Colfax
Clay
Lavette
McAllister
Broadway
Pavone
Pearl
Superior
Division
Niles
Clay
Baird
Empire
Weld
Agard
Columbus
Ogden
Cross
Emery
Monroe
Jennings
Bishop
Union
Hurd
Milton
David Adkins
Hubbard
Carlton
Southport
Rizzo
Michigan
Reeder
Rose
Allen
Eureka
Martin Luther King
Fair
Pitkins
Warwick
College
Packard
McCord
McGuigan
Vineyard
Davar
Nate Wells Sr
High
Hall
Buss
Sickle
Boss
Thresher
Highland
Hull
Cass
Nowlen
Winans
Benton
Seeley
Oden
Cornelia
Chestnut
Territorial
Chicago
Green
Edwards
La Salle
Forest
John
McCord
Fair
Woodland
Stevens
Winans
Nowlen
Riford
North
Miller
Morton
2nd
3rd
4th
5th
6th
Water
Park
Shore
8th
Michigan
Homack
Church
Jefferson
Brunson
Lincoln
Ross
Bellview
Lake
Ohio
Maple
Colby
Kirby
Kirby
Ceda
Valley
Wall
Oak
9th
10th
12th
11th
8th
Riverview
Shoreview
Anchors
Industrial
Anchor
Island Pointe
Pearl
Ann
Broad
Langley
River
Manley
Michigan
Margaret
Bluff
Marion
Woodward
Salem
Searles
May
Parker
Hastings
Robbins
Windsor
Seneca
Utica
Cherokee
Western
Eastern
Orchard
Emery
Emery
Cross
Weld
Division
Niles
Clay
Baird
Empire
Foster
Pipestone
Heck
Colfax
Clay
Lavette
McAllister
Broadway
Pearl
Superior
Columbus
Ogden
Agard
Agard

APPENDIX F

CIP PLAN ESTIMATES

5-Year CIP

20-Year CIP

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Britain Avenue (Riverview to Pipestone)
Prepared By: Aaron Townley, EIT

Britain Avenue (Riverview to Pipestone)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 203,600.00	$ 203,600.00
2	Traffic Control	LSum	1	$ 97,000.00	$ 97,000.00
3	Machine Grading	Sta	59.1	$ 1,200.00	$ 70,920.00
4	Pavt, Rem, Modified	Syd	7224	$ 9.00	$ 65,016.00
5	Aggregate Base, 8 inch	Syd	7224	$ 9.00	$ 65,016.00
6	Subbase, CIP (12 Inches)	Cyd	2408	$ 13.50	$ 32,508.00
7	HMA Surface	Ton	2086	$ 80.00	$ 166,880.00
8	Fire Hydrant Assembly	Ea	15	$ 4,000.00	$ 60,000.00
9	Gate Valve & Box, 16 Inch	Ea	17	$ 6,500.00	$ 110,500.00
10	Water Main, DI, 16 Inch, Tr Det G	Ft	5910	$ 200.00	$ 1,182,000.00
11	Water Service	Ea	79	$ 1,750.00	$ 138,250.00
12	Curb Stop and Box	Ea	79	$ 500.00	$ 39,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	1580	$ 5.00	$ 7,900.00
Britain Avenue (Riverview to Pipestone) Estimate					$ 2,239,090.00
Contingency				**15%**	$ 335,900.00
Engineering & Construction Administration				**20%**	$ 447,900.00
Total Estimated Water Main Construction Costs					$ 3,022,890.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: 8th Street (Hinkley to Britain)
Prepared By: Aaron Townley, EIT

8th Street (Hinkley to Britain)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 119,300.00	$ 119,300.00
2	Traffic Control	LSum	1	$ 56,800.00	$ 56,800.00
3	Machine Grading	Sta	46.73	$ 1,200.00	$ 56,076.00
4	Pavt, Rem, Modified	Syd	5712	$ 9.00	$ 51,408.00
5	Aggregate Base, 8 inch	Syd	5712	$ 9.00	$ 51,408.00
6	Subbase, CIP (12 Inches)	Cyd	1904	$ 13.50	$ 25,704.00
7	HMA Surface	Ton	1650	$ 80.00	$ 132,000.00
8	Fire Hydrant Assembly	Ea	12	$ 4,000.00	$ 48,000.00
9	Gate Valve & Box, 12 Inch	Ea	14	$ 2,750.00	$ 38,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	4673	$ 125.00	$ 584,125.00
11	Water Service	Ea	63	$ 1,750.00	$ 110,250.00
12	Curb Stop and Box	Ea	63	$ 500.00	$ 31,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	1260	$ 5.00	$ 6,300.00
8th Street (Hinkley to Britain) Estimate					$ 1,311,371.00
Contingency				**15%**	$ 196,800.00
Engineering & Construction Administration				**20%**	$ 262,300.00
Total Estimated Water Main Construction Costs					$ 1,770,471.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Pipestone Rd (Main Street to Washington Street)
Prepared By: Aaron Townley, EIT

Pipestone Rd (Main Street to Washington Street)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 48,500.00	$ 48,500.00
2	Traffic Control	LSum	1	$ 23,100.00	$ 23,100.00
3	Machine Grading	Sta	18.86	$ 1,200.00	$ 22,632.00
4	Pavt, Rem, Modified	Syd	2306	$ 9.00	$ 20,754.00
5	Aggregate Base, 8 inch	Syd	2306	$ 9.00	$ 20,754.00
6	Subbase, CIP (12 Inches)	Cyd	769	$ 13.50	$ 10,381.50
7	HMA Surface	Ton	666	$ 80.00	$ 53,280.00
8	Fire Hydrant Assembly	Ea	5	$ 4,000.00	$ 20,000.00
9	Gate Valve & Box, 12 Inch	Ea	6	$ 2,750.00	$ 16,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	1886	$ 125.00	$ 235,750.00
11	Water Service	Ea	26	$ 1,750.00	$ 45,500.00
12	Curb Stop and Box	Ea	26	$ 500.00	$ 13,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	520	$ 5.00	$ 2,600.00
Pipestone Rd (Main Street to Washington Street) Estimate					$ 532,751.50
Contingency				**15%**	$ 80,000.00
Engineering & Construction Administration				**20%**	$ 106,600.00
Total Estimated Water Main Construction Costs					$ 719,351.50

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Project Name:Benton Harbor Water Asset Management Plan
Project Location: Michigan St. / E. Wall St / Highland Ave (Pipestone St to Jefferson)
Prepared By: Aaron Townley, EIT

Michigan St. / E. Wall St / Highland Ave (Pipestone St to Jefferson)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 50,800.00	$ 50,800.00
2	Traffic Control	LSum	1	$ 24,200.00	$ 24,200.00
3	Machine Grading	Sta	19.89	$ 1,200.00	$ 23,868.00
4	Pavt, Rem, Modified	Syd	2431	$ 9.00	$ 21,879.00
5	Aggregate Base, 8 inch	Syd	2431	$ 9.00	$ 21,879.00
6	Subbase, CIP (12 Inches)	Cyd	811	$ 13.50	$ 10,948.50
7	HMA Surface	Ton	702	$ 80.00	$ 56,160.00
8	Fire Hydrant Assembly	Ea	5	$ 4,000.00	$ 20,000.00
9	Gate Valve & Box, 12 Inch	Ea	6	$ 2,750.00	$ 16,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	1989	$ 125.00	$ 248,625.00
11	Water Service	Ea	27	$ 1,750.00	$ 47,250.00
12	Curb Stop and Box	Ea	27	$ 500.00	$ 13,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	540	$ 5.00	$ 2,700.00
Michigan St. / E. Wall St / Highland Ave (Pipestone St to Jefferson) Estimate					$ 558,309.50
Contingency				**15%**	$ 83,800.00
Engineering & Construction Administration				**20%**	$ 111,700.00
Total Estimated Water Main Construction Costs					$ 753,809.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Whitwam-Riverview Dr (Main Street to Whitwam Dr)
Prepared By: Aaron Townley, EIT

Whitwam-Riverview Dr (Main Street to Whitwam Dr)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 19,700.00	$ 19,700.00
2	Traffic Control	LSum	1	$ 9,400.00	$ 9,400.00
3	Machine Grading	Sta	7.54	$ 1,200.00	$ 9,048.00
4	Pavt, Rem, Modified	Syd	922	$ 9.00	$ 8,298.00
5	Aggregate Base, 8 inch	Syd	922	$ 9.00	$ 8,298.00
6	Subbase, CIP (12 Inches)	Cyd	308	$ 13.50	$ 4,158.00
7	HMA Surface	Ton	267	$ 80.00	$ 21,360.00
8	Fire Hydrant Assembly	Ea	2	$ 4,000.00	$ 8,000.00
9	Gate Valve & Box, 12 Inch	Ea	3	$ 2,750.00	$ 8,250.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	754	$ 125.00	$ 94,250.00
11	Water Service	Ea	11	$ 1,750.00	$ 19,250.00
12	Curb Stop and Box	Ea	11	$ 500.00	$ 5,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	220	$ 5.00	$ 1,100.00
Whitwam-Riverview Dr (Main Street to Whitwam Dr) Estimate					$ 216,612.00
Contingency				**15%**	$ 32,500.00
Engineering & Construction Administration				**20%**	$ 43,400.00
Total Estimated Water Main Construction Costs					$ 292,512.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Empire Ave (Riverview Dr to Salem Ave)
Prepared By: Aaron Townley, EIT

Empire Ave (Riverview Dr to Salem Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 49,600.00	$ 49,600.00
2	Traffic Control	LSum	1	$ 23,600.00	$ 23,600.00
3	Machine Grading	Sta	19.42	$ 1,200.00	$ 23,304.00
4	Pavt, Rem, Modified	Syd	2374	$ 9.00	$ 21,366.00
5	Aggregate Base, 8 inch	Syd	2374	$ 9.00	$ 21,366.00
6	Subbase, CIP (12 Inches)	Cyd	792	$ 13.50	$ 10,692.00
7	HMA Surface	Ton	686	$ 80.00	$ 54,880.00
8	Fire Hydrant Assembly	Ea	5	$ 4,000.00	$ 20,000.00
9	Gate Valve & Box, 12 Inch	Ea	6	$ 2,750.00	$ 16,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	1942	$ 125.00	$ 242,750.00
11	Water Service	Ea	26	$ 1,750.00	$ 45,500.00
12	Curb Stop and Box	Ea	26	$ 500.00	$ 13,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	520	$ 5.00	$ 2,600.00
Empire Ave (Riverview Dr to Salem Ave) Estimate					$ 545,158.00
Contingency				**15%**	$ 81,800.00
Engineering & Construction Administration				**20%**	$ 109,100.00
Total Estimated Water Main Construction Costs					$ 736,058.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Empire Ave (Columbus Ave to Ogden Ave)
Prepared By: Aaron Townley, EIT

Empire Ave (Columbus Ave to Ogden Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 12,900.00	$ 12,900.00
2	Traffic Control	LSum	1	$ 6,200.00	$ 6,200.00
3	Machine Grading	Sta	6.28	$ 1,200.00	$ 7,536.00
4	Pavt, Rem, Modified	Syd	768	$ 9.00	$ 6,912.00
5	Aggregate Base, 8 inch	Syd	768	$ 9.00	$ 6,912.00
6	Subbase, CIP (12 Inches)	Cyd	256	$ 13.50	$ 3,456.00
7	HMA Surface	Ton	222	$ 80.00	$ 17,760.00
8	Fire Hydrant Assembly	Ea	2	$ 4,000.00	$ 8,000.00
9	Gate Valve & Box, 8 Inch	Ea	2	$ 1,750.00	$ 3,500.00
10	Water Main, DI, 8 Inch, Tr Det G	Ft	628	$ 75.00	$ 47,100.00
11	Water Service	Ea	9	$ 1,750.00	$ 15,750.00
12	Curb Stop and Box	Ea	9	$ 500.00	$ 4,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	180	$ 5.00	$ 900.00
Empire Ave (Columbus Ave to Ogden Ave) Estimate					$ 141,426.00
Contingency				**15%**	$ 21,300.00
Engineering & Construction Administration				**20%**	$ 28,300.00
Total Estimated Water Main Construction Costs					$ 191,026.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Empire Ave (Jennings Ave to Pipestone St)
Prepared By: Aaron Townley, EIT

Empire Ave (Jennings Ave to Pipestone St)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 20,500.00	$ 20,500.00
2	Traffic Control	LSum	1	$ 9,800.00	$ 9,800.00
3	Machine Grading	Sta	10.09	$ 1,200.00	$ 12,108.00
4	Pavt, Rem, Modified	Syd	1234	$ 9.00	$ 11,106.00
5	Aggregate Base, 8 inch	Syd	1234	$ 9.00	$ 11,106.00
6	Subbase, CIP (12 Inches)	Cyd	412	$ 13.50	$ 5,562.00
7	HMA Surface	Ton	357	$ 80.00	$ 28,560.00
8	Fire Hydrant Assembly	Ea	3	$ 4,000.00	$ 12,000.00
9	Gate Valve & Box, 8 Inch	Ea	3	$ 1,750.00	$ 5,250.00
10	Water Main, DI, 8 Inch, Tr Det G	Ft	1009	$ 75.00	$ 75,675.00
11	Water Service	Ea	14	$ 1,750.00	$ 24,500.00
12	Curb Stop and Box	Ea	14	$ 500.00	$ 7,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	280	$ 5.00	$ 1,400.00
Empire Ave (Jennings Ave to Pipestone St) Estimate					$ 224,567.00
Contingency				**15%**	$ 33,700.00
Engineering & Construction Administration				**20%**	$ 45,000.00
Total Estimated Water Main Construction Costs					$ 303,267.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Salem Ave (Empire Ave to May St to Colfax Ave)
Prepared By: Aaron Townley, EIT

Salem Ave (Empire Ave to May St to Colfax Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 40,500.00	$ 40,500.00
2	Traffic Control	LSum	1	$ 19,300.00	$ 19,300.00
3	Machine Grading	Sta	20.13	$ 1,200.00	$ 24,156.00
4	Pavt, Rem, Modified	Syd	2461	$ 9.00	$ 22,149.00
5	Aggregate Base, 8 inch	Syd	2461	$ 9.00	$ 22,149.00
6	Subbase, CIP (12 Inches)	Cyd	821	$ 13.50	$ 11,083.50
7	HMA Surface	Ton	711	$ 80.00	$ 56,880.00
8	Fire Hydrant Assembly	Ea	6	$ 4,000.00	$ 24,000.00
9	Gate Valve & Box, 8 Inch	Ea	6	$ 1,750.00	$ 10,500.00
10	Water Main, DI, 8 Inch, Tr Det G	Ft	2013	$ 75.00	$ 150,975.00
11	Water Service	Ea	27	$ 1,750.00	$ 47,250.00
12	Curb Stop and Box	Ea	27	$ 500.00	$ 13,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	540	$ 5.00	$ 2,700.00
Salem Ave (Empire Ave to May St to Colfax Ave) Estimate					$ 445,142.50
Contingency				**15%**	$ 66,800.00
Engineering & Construction Administration				**20%**	$ 89,100.00
Total Estimated Water Main Construction Costs					$ 601,042.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Emery Ave (Union St to Milton and Hurd Ave south)
Prepared By: Aaron Townley, EIT

Emery Ave (Union St to Milton and Hurd Ave south)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 35,000.00	$ 35,000.00
2	Traffic Control	LSum	1	$ 16,700.00	$ 16,700.00
3	Machine Grading	Sta	17.36	$ 1,200.00	$ 20,832.00
4	Pavt, Rem, Modified	Syd	2122	$ 9.00	$ 19,098.00
5	Aggregate Base, 8 inch	Syd	2122	$ 9.00	$ 19,098.00
6	Subbase, CIP (12 Inches)	Cyd	708	$ 13.50	$ 9,558.00
7	HMA Surface	Ton	613	$ 80.00	$ 49,040.00
8	Fire Hydrant Assembly	Ea	5	$ 4,000.00	$ 20,000.00
9	Gate Valve & Box, 8 Inch	Ea	5	$ 1,750.00	$ 8,750.00
10	Water Main, DI, 8 Inch, Tr Det G	Ft	1736	$ 75.00	$ 130,200.00
11	Water Service	Ea	24	$ 1,750.00	$ 42,000.00
12	Curb Stop and Box	Ea	24	$ 500.00	$ 12,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	480	$ 5.00	$ 2,400.00
Emery Ave (Union St to Milton and Hurd Ave south) Estimate					$ 384,676.00
Contingency				**15%**	$ 57,800.00
Engineering & Construction Administration				**20%**	$ 77,000.00
Total Estimated Water Main Construction Costs					$ 519,476.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Pearl St (Catalpa Ave to Empire Ave)
Prepared By: Aaron Townley, EIT

Pearl St (Catalpa Ave to Empire Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 43,300.00	$ 43,300.00
2	Traffic Control	LSum	1	$ 20,600.00	$ 20,600.00
3	Machine Grading	Sta	18.21	$ 1,200.00	$ 21,852.00
4	Pavt, Rem, Modified	Syd	2226	$ 9.00	$ 20,034.00
5	Aggregate Base, 8 inch	Syd	2226	$ 9.00	$ 20,034.00
6	Subbase, CIP (12 Inches)	Cyd	742	$ 13.50	$ 10,017.00
7	HMA Surface	Ton	386	$ 80.00	$ 30,880.00
8	Fire Hydrant Assembly	Ea	5	$ 4,000.00	$ 20,000.00
9	Gate Valve & Box, 12 Inch	Ea	6	$ 2,750.00	$ 16,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	1821	$ 125.00	$ 227,625.00
11	Water Service	Ea	19	$ 1,750.00	$ 33,250.00
12	Curb Stop and Box	Ea	19	$ 500.00	$ 9,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	380	$ 5.00	$ 1,900.00
Pearl St (Catalpa Ave to Empire Ave) Estimate					$ 475,492.00
Contingency				**15%**	$ 71,400.00
Engineering & Construction Administration				**20%**	$ 95,100.00
Total Estimated Water Main Construction Costs					$ 641,992.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Catalpa Ave (Colfax Ave to Columbus Ave)
Prepared By: Aaron Townley, EIT

Catalpa Ave (Colfax Ave to Columbus Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 45,400.00	$ 45,400.00
2	Traffic Control	LSum	1	$ 21,700.00	$ 21,700.00
3	Machine Grading	Sta	19.22	$ 1,200.00	$ 23,064.00
4	Pavt, Rem, Modified	Syd	2350	$ 9.00	$ 21,150.00
5	Aggregate Base, 8 inch	Syd	2350	$ 9.00	$ 21,150.00
6	Subbase, CIP (12 Inches)	Cyd	784	$ 13.50	$ 10,584.00
7	HMA Surface	Ton	407	$ 80.00	$ 32,560.00
8	Fire Hydrant Assembly	Ea	5	$ 4,000.00	$ 20,000.00
9	Gate Valve & Box, 12 Inch	Ea	6	$ 2,750.00	$ 16,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	1922	$ 125.00	$ 240,250.00
11	Water Service	Ea	20	$ 1,750.00	$ 35,000.00
12	Curb Stop and Box	Ea	20	$ 500.00	$ 10,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	400	$ 5.00	$ 2,000.00
Catalpa Ave (Colfax Ave to Columbus Ave) Estimate					$ 499,358.00
Contingency				**15%**	$ 75,000.00
Engineering & Construction Administration				**20%**	$ 99,900.00
Total Estimated Water Main Construction Costs					$ 674,258.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Pavone St (Lake Ave to Catalpa Ave)
Prepared By: Aaron Townley, EIT

Pavone St (Lake Ave to Catalpa Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 39,300.00	$ 39,300.00
2	Traffic Control	LSum	1	$ 18,700.00	$ 18,700.00
3	Machine Grading	Sta	16.52	$ 1,200.00	$ 19,824.00
4	Pavt, Rem, Modified	Syd	2020	$ 9.00	$ 18,180.00
5	Aggregate Base, 8 inch	Syd	2020	$ 9.00	$ 18,180.00
6	Subbase, CIP (12 Inches)	Cyd	674	$ 13.50	$ 9,099.00
7	HMA Surface	Ton	350	$ 80.00	$ 28,000.00
8	Fire Hydrant Assembly	Ea	5	$ 4,000.00	$ 20,000.00
9	Gate Valve & Box, 12 Inch	Ea	5	$ 2,750.00	$ 13,750.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	1652	$ 125.00	$ 206,500.00
11	Water Service	Ea	17	$ 1,750.00	$ 29,750.00
12	Curb Stop and Box	Ea	17	$ 500.00	$ 8,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	340	$ 5.00	$ 1,700.00
Pavone St (Lake Ave to Catalpa Ave) Estimate					$ 431,483.00
Contingency				**15%**	$ 64,800.00
Engineering & Construction Administration				**20%**	$ 86,300.00
Total Estimated Water Main Construction Costs					$ 582,583.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Ohio St Alleys (Britain Ave to Pavone St)
Prepared By: Aaron Townley, EIT

Ohio St Alleys (Britain Ave to Pavone St)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 21,100.00	$ 21,100.00
2	Traffic Control	LSum	1	$ 10,100.00	$ 10,100.00
3	Machine Grading	Sta	8.78	$ 1,200.00	$ 10,536.00
4	Pavt, Rem, Modified	Syd	1074	$ 9.00	$ 9,666.00
5	Aggregate Base, 8 inch	Syd	1074	$ 9.00	$ 9,666.00
6	Subbase, CIP (12 Inches)	Cyd	358	$ 13.50	$ 4,833.00
7	HMA Surface	Ton	186	$ 80.00	$ 14,880.00
8	Fire Hydrant Assembly	Ea	3	$ 4,000.00	$ 12,000.00
9	Gate Valve & Box, 12 Inch	Ea	3	$ 2,750.00	$ 8,250.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	878	$ 125.00	$ 109,750.00
11	Water Service	Ea	9	$ 1,750.00	$ 15,750.00
12	Curb Stop and Box	Ea	9	$ 500.00	$ 4,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	180	$ 5.00	$ 900.00
Ohio St Alleys (Britain Ave to Pavone St) Estimate					$ 231,931.00
Contingency				**15%**	$ 34,800.00
Engineering & Construction Administration				**20%**	$ 46,400.00
Total Estimated Water Main Construction Costs					$ 313,131.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Lake Ave (Market St to Broadway Ave)
Prepared By: Aaron Townley, EIT

Lake Ave (Market St to Broadway Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 47,500.00	$ 47,500.00
2	Traffic Control	LSum	1	$ 22,700.00	$ 22,700.00
3	Machine Grading	Sta	18.51	$ 1,200.00	$ 22,212.00
4	Pavt, Rem, Modified	Syd	2263	$ 9.00	$ 20,367.00
5	Aggregate Base, 8 inch	Syd	2263	$ 9.00	$ 20,367.00
6	Subbase, CIP (12 Inches)	Cyd	755	$ 13.50	$ 10,192.50
7	HMA Surface	Ton	654	$ 80.00	$ 52,320.00
8	Fire Hydrant Assembly	Ea	5	$ 4,000.00	$ 20,000.00
9	Gate Valve & Box, 12 Inch	Ea	6	$ 2,750.00	$ 16,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	1851	$ 125.00	$ 231,375.00
11	Water Service	Ea	25	$ 1,750.00	$ 43,750.00
12	Curb Stop and Box	Ea	25	$ 500.00	$ 12,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	500	$ 5.00	$ 2,500.00
Lake Ave (Market St to Broadway Ave) Estimate					$ 522,283.50
Contingency				**15%**	$ 78,400.00
Engineering & Construction Administration				**20%**	$ 104,500.00
Total Estimated Water Main Construction Costs					$ 705,183.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Broadway Ave / Jefferson St (Lake Ave to Highland Ave)
Prepared By: Aaron Townley, EIT

Broadway Ave / Jefferson St (Lake Ave to Highland Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 48,600.00	$ 48,600.00
2	Traffic Control	LSum	1	$ 23,100.00	$ 23,100.00
3	Machine Grading	Sta	18.9	$ 1,200.00	$ 22,680.00
4	Pavt, Rem, Modified	Syd	2310	$ 9.00	$ 20,790.00
5	Aggregate Base, 8 inch	Syd	2310	$ 9.00	$ 20,790.00
6	Subbase, CIP (12 Inches)	Cyd	770	$ 13.50	$ 10,395.00
7	HMA Surface	Ton	668	$ 80.00	$ 53,440.00
8	Fire Hydrant Assembly	Ea	5	$ 4,000.00	$ 20,000.00
9	Gate Valve & Box, 12 Inch	Ea	6	$ 2,750.00	$ 16,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	1890	$ 125.00	$ 236,250.00
11	Water Service	Ea	26	$ 1,750.00	$ 45,500.00
12	Curb Stop and Box	Ea	26	$ 500.00	$ 13,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	520	$ 5.00	$ 2,600.00
Broadway Ave / Jefferson St (Lake Ave to Highland Ave) Estimate					$ 533,645.00
Contingency				**15%**	$ 80,100.00
Engineering & Construction Administration				**20%**	$ 106,800.00
Total Estimated Water Main Construction Costs					$ 720,545.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: McCord St (Main St to Britain Ave)
Prepared By: Aaron Townley, EIT

McCord St (Main St to Britain Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 89,000.00	$ 89,000.00
2	Traffic Control	LSum	1	$ 42,400.00	$ 42,400.00
3	Machine Grading	Sta	34.91	$ 1,200.00	$ 41,892.00
4	Pavt, Rem, Modified	Syd	4267	$ 9.00	$ 38,403.00
5	Aggregate Base, 8 inch	Syd	4267	$ 9.00	$ 38,403.00
6	Subbase, CIP (12 Inches)	Cyd	1423	$ 13.50	$ 19,210.50
7	HMA Surface	Ton	1233	$ 80.00	$ 98,640.00
8	Fire Hydrant Assembly	Ea	9	$ 4,000.00	$ 36,000.00
9	Gate Valve & Box, 12 Inch	Ea	10	$ 2,750.00	$ 27,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	3491	$ 125.00	$ 436,375.00
11	Water Service	Ea	47	$ 1,750.00	$ 82,250.00
12	Curb Stop and Box	Ea	47	$ 500.00	$ 23,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	940	$ 5.00	$ 4,700.00
McCord St (Main St to Britain Ave) Estimate					$ 978,273.50
Contingency				**15%**	$ 146,800.00
Engineering & Construction Administration				**20%**	$ 195,700.00
Total Estimated Water Main Construction Costs					$ 1,320,773.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: 2nd St, Klock Rd to Highland Ave
Prepared By: Aaron Townley, EIT

2nd St, Klock Rd to Highland Ave					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 107,500.00	$ 107,500.00
2	Traffic Control	LSum	1	$ 51,200.00	$ 51,200.00
3	Machine Grading	Sta	31.16	$ 1,200.00	$ 37,392.00
4	Pavt, Rem, Modified	Syd	3809	$ 9.00	$ 34,281.00
5	Aggregate Base, 8 inch	Syd	3809	$ 9.00	$ 34,281.00
6	Subbase, CIP (12 Inches)	Cyd	1270	$ 13.50	$ 17,145.00
7	HMA Surface	Ton	1100	$ 80.00	$ 88,000.00
8	Fire Hydrant Assembly	Ea	8	$ 4,000.00	$ 32,000.00
9	Gate Valve & Box, 16 Inch	Ea	9	$ 6,500.00	$ 58,500.00
10	Water Main, DI, 16 Inch, Tr Det G	Ft	3116	$ 200.00	$ 623,200.00
11	Water Service	Ea	42	$ 1,750.00	$ 73,500.00
12	Curb Stop and Box	Ea	42	$ 500.00	$ 21,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	840	$ 5.00	$ 4,200.00
2nd St, Klock Rd to Highland Ave Estimate					$ 1,182,199.00
Contingency				**15%**	$ 177,400.00
Engineering & Construction Administration				**20%**	$ 236,500.00
Total Estimated Water Main Construction Costs					$ 1,596,099.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Waukonda Ave (Nowlen St to Fair Ave)
Prepared By: Aaron Townley, EIT

Waukonda Ave (Nowlen St to Fair Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 48,000.00	$ 48,000.00
2	Traffic Control	LSum	1	$ 22,900.00	$ 22,900.00
3	Machine Grading	Sta	20.23	$ 1,200.00	$ 24,276.00
4	Pavt, Rem, Modified	Syd	2473	$ 9.00	$ 22,257.00
5	Aggregate Base, 8 inch	Syd	2473	$ 9.00	$ 22,257.00
6	Subbase, CIP (12 Inches)	Cyd	825	$ 13.50	$ 11,137.50
7	HMA Surface	Ton	429	$ 80.00	$ 34,320.00
8	Fire Hydrant Assembly	Ea	6	$ 4,000.00	$ 24,000.00
9	Gate Valve & Box, 12 Inch	Ea	6	$ 2,750.00	$ 16,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	2023	$ 125.00	$ 252,875.00
11	Water Service	Ea	21	$ 1,750.00	$ 36,750.00
12	Curb Stop and Box	Ea	21	$ 500.00	$ 10,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	420	$ 5.00	$ 2,100.00
Waukonda Ave (Nowlen St to Fair Ave) Estimate					$ 527,872.50
Contingency				**15%**	$ 79,200.00
Engineering & Construction Administration				**20%**	$ 105,600.00
Total Estimated Water Main Construction Costs					$ 712,672.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Bond St (Market St to Colfax Ave)
Prepared By: Aaron Townley, EIT

Bond St (Market St to Colfax Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 53,500.00	$ 53,500.00
2	Traffic Control	LSum	1	$ 25,500.00	$ 25,500.00
3	Machine Grading	Sta	26.77	$ 1,200.00	$ 32,124.00
4	Pavt, Rem, Modified	Syd	3272	$ 9.00	$ 29,448.00
5	Aggregate Base, 8 inch	Syd	3272	$ 9.00	$ 29,448.00
6	Subbase, CIP (12 Inches)	Cyd	1091	$ 13.50	$ 14,728.50
7	HMA Surface	Ton	945	$ 80.00	$ 75,600.00
8	Fire Hydrant Assembly	Ea	7	$ 4,000.00	$ 28,000.00
9	Gate Valve & Box, 8 Inch	Ea	8	$ 1,750.00	$ 14,000.00
10	Water Main, DI, 8 Inch, Tr Det G	Ft	2677	$ 75.00	$ 200,775.00
11	Water Service	Ea	36	$ 1,750.00	$ 63,000.00
12	Curb Stop and Box	Ea	36	$ 500.00	$ 18,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	720	$ 5.00	$ 3,600.00
Bond St (Market St to Colfax Ave) Estimate					$ 587,723.50
Contingency				**15%**	$ 88,200.00
Engineering & Construction Administration				**20%**	$ 117,600.00
Total Estimated Water Main Construction Costs					$ 793,523.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: 9th St (Main St to Oak St)
Prepared By: Aaron Townley, EIT

9th St (Main St to Oak St)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 19,800.00	$ 19,800.00
2	Traffic Control	LSum	1	$ 9,500.00	$ 9,500.00
3	Machine Grading	Sta	7.57	$ 1,200.00	$ 9,084.00
4	Pavt, Rem, Modified	Syd	926	$ 9.00	$ 8,334.00
5	Aggregate Base, 8 inch	Syd	926	$ 9.00	$ 8,334.00
6	Subbase, CIP (12 Inches)	Cyd	309	$ 13.50	$ 4,171.50
7	HMA Surface	Ton	268	$ 80.00	$ 21,440.00
8	Fire Hydrant Assembly	Ea	2	$ 4,000.00	$ 8,000.00
9	Gate Valve & Box, 12 Inch	Ea	3	$ 2,750.00	$ 8,250.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	757	$ 125.00	$ 94,625.00
11	Water Service	Ea	11	$ 1,750.00	$ 19,250.00
12	Curb Stop and Box	Ea	11	$ 500.00	$ 5,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	220	$ 5.00	$ 1,100.00
9th St (Main St to Oak St) Estimate					$ 217,388.50
Contingency				**15%**	$ 32,700.00
Engineering & Construction Administration				**20%**	$ 43,500.00
Total Estimated Water Main Construction Costs					$ 293,588.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Territorial Rd (4th St to 2nd St)
Prepared By: Aaron Townley, EIT

Territorial Rd (4th St to 2nd St)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 19,300.00	$ 19,300.00
2	Traffic Control	LSum	1	$ 9,200.00	$ 9,200.00
3	Machine Grading	Sta	7.43	$ 1,200.00	$ 8,916.00
4	Pavt, Rem, Modified	Syd	909	$ 9.00	$ 8,181.00
5	Aggregate Base, 8 inch	Syd	909	$ 9.00	$ 8,181.00
6	Subbase, CIP (12 Inches)	Cyd	303	$ 13.50	$ 4,090.50
7	HMA Surface	Ton	263	$ 80.00	$ 21,040.00
8	Fire Hydrant Assembly	Ea	2	$ 4,000.00	$ 8,000.00
9	Gate Valve & Box, 12 Inch	Ea	3	$ 2,750.00	$ 8,250.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	743	$ 125.00	$ 92,875.00
11	Water Service	Ea	10	$ 1,750.00	$ 17,500.00
12	Curb Stop and Box	Ea	10	$ 500.00	$ 5,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	200	$ 5.00	$ 1,000.00
Territorial Rd (4th St to 2nd St) Estimate					$ 211,533.50
Contingency				**15%**	$ 31,800.00
Engineering & Construction Administration				**20%**	$ 42,400.00
Total Estimated Water Main Construction Costs					$ 285,733.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: 3rd St / East Alley (Territorial to Highland Ave)
Prepared By: Aaron Townley, EIT

3rd St / East Alley (Territorial to Highland Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 28,200.00	$ 28,200.00
2	Traffic Control	LSum	1	$ 13,400.00	$ 13,400.00
3	Machine Grading	Sta	10.88	$ 1,200.00	$ 13,056.00
4	Pavt, Rem, Modified	Syd	1330	$ 9.00	$ 11,970.00
5	Aggregate Base, 8 inch	Syd	1330	$ 9.00	$ 11,970.00
6	Subbase, CIP (12 Inches)	Cyd	444	$ 13.50	$ 5,994.00
7	HMA Surface	Ton	384	$ 80.00	$ 30,720.00
8	Fire Hydrant Assembly	Ea	3	$ 4,000.00	$ 12,000.00
9	Gate Valve & Box, 12 Inch	Ea	4	$ 2,750.00	$ 11,000.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	1088	$ 125.00	$ 136,000.00
11	Water Service	Ea	15	$ 1,750.00	$ 26,250.00
12	Curb Stop and Box	Ea	15	$ 500.00	$ 7,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	300	$ 5.00	$ 1,500.00
3rd St / East Alley (Territorial to Highland Ave) Estimate					$ 309,560.00
Contingency				**15%**	$ 46,500.00
Engineering & Construction Administration				**20%**	$ 62,000.00
Total Estimated Water Main Construction Costs					$ 418,060.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: 8th St (Klock Rd to Graham Ave)
Prepared By: Aaron Townley, EIT

8th St (Klock Rd to Graham Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 64,400.00	$ 64,400.00
2	Traffic Control	LSum	1	$ 30,700.00	$ 30,700.00
3	Machine Grading	Sta	18.48	$ 1,200.00	$ 22,176.00
4	Pavt, Rem, Modified	Syd	2259	$ 9.00	$ 20,331.00
5	Aggregate Base, 8 inch	Syd	2259	$ 9.00	$ 20,331.00
6	Subbase, CIP (12 Inches)	Cyd	753	$ 13.50	$ 10,165.50
7	HMA Surface	Ton	653	$ 80.00	$ 52,240.00
8	Fire Hydrant Assembly	Ea	5	$ 4,000.00	$ 20,000.00
9	Gate Valve & Box, 16 Inch	Ea	6	$ 6,500.00	$ 39,000.00
10	Water Main, DI, 16 Inch, Tr Det G	Ft	1848	$ 200.00	$ 369,600.00
11	Water Service	Ea	25	$ 1,750.00	$ 43,750.00
12	Curb Stop and Box	Ea	25	$ 500.00	$ 12,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	500	$ 5.00	$ 2,500.00
8th St (Klock Rd to Graham Ave) Estimate					$ 707,693.50
Contingency				**15%**	$ 106,200.00
Engineering & Construction Administration				**20%**	$ 141,600.00
Total Estimated Water Main Construction Costs					$ 955,493.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Wall St (Riverview Dr to 12th St)
Prepared By: Aaron Townley, EIT

Wall St (Riverview Dr to 12th St)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 33,900.00	$ 33,900.00
2	Traffic Control	LSum	1	$ 16,200.00	$ 16,200.00
3	Machine Grading	Sta	9.73	$ 1,200.00	$ 11,676.00
4	Pavt, Rem, Modified	Syd	1190	$ 9.00	$ 10,710.00
5	Aggregate Base, 8 inch	Syd	1190	$ 9.00	$ 10,710.00
6	Subbase, CIP (12 Inches)	Cyd	397	$ 13.50	$ 5,359.50
7	HMA Surface	Ton	344	$ 80.00	$ 27,520.00
8	Fire Hydrant Assembly	Ea	3	$ 4,000.00	$ 12,000.00
9	Gate Valve & Box, 16 Inch	Ea	3	$ 6,500.00	$ 19,500.00
10	Water Main, DI, 16 Inch, Tr Det G	Ft	973	$ 200.00	$ 194,600.00
11	Water Service	Ea	13	$ 1,750.00	$ 22,750.00
12	Curb Stop and Box	Ea	13	$ 500.00	$ 6,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	260	$ 5.00	$ 1,300.00
Wall St (Riverview Dr to 12th St) Estimate					$ 372,725.50
Contingency				**15%**	$ 56,000.00
Engineering & Construction Administration				**20%**	$ 74,600.00
Total Estimated Water Main Construction Costs					$ 503,325.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Hull Ave (Frank St to ~350 ft North of Edwards Ave)
Prepared By: Aaron Townley, EIT

Hull Ave (Frank St to ~350 ft North of Edwards Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 10,300.00	$ 10,300.00
2	Traffic Control	LSum	1	$ 4,900.00	$ 4,900.00
3	Machine Grading	Sta	5.5	$ 1,200.00	$ 6,600.00
4	Pavt, Rem, Modified	Syd	673	$ 9.00	$ 6,057.00
5	Aggregate Base, 8 inch	Syd	673	$ 9.00	$ 6,057.00
6	Subbase, CIP (12 Inches)	Cyd	225	$ 13.50	$ 3,037.50
7	HMA Surface	Ton	117	$ 80.00	$ 9,360.00
8	Fire Hydrant Assembly	Ea	2	$ 4,000.00	$ 8,000.00
9	Gate Valve & Box, 8 Inch	Ea	2	$ 1,750.00	$ 3,500.00
10	Water Main, DI, 8 Inch, Tr Det G	Ft	550	$ 75.00	$ 41,250.00
11	Water Service	Ea	6	$ 1,750.00	$ 10,500.00
12	Curb Stop and Box	Ea	6	$ 500.00	$ 3,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	120	$ 5.00	$ 600.00
Hull Ave (Frank St to ~350 ft North of Edwards Ave) Estimate					$ 113,161.50
Contingency				**15%**	$ 17,000.00
Engineering & Construction Administration				**20%**	$ 22,700.00
Total Estimated Water Main Construction Costs					$ 152,861.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Klock Rd, Water Plant to East
Prepared By: Aaron Townley, EIT

Klock Rd, Water Plant to East					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 31,100.00	$ 31,100.00
2	Traffic Control	LSum	1	$ 14,800.00	$ 14,800.00
3	Machine Grading	Sta	8.8	$ 1,200.00	$ 10,560.00
4	Pavt, Rem, Modified	Syd	1076	$ 9.00	$ 9,684.00
5	Aggregate Base, 8 inch	Syd	1076	$ 9.00	$ 9,684.00
6	Subbase, CIP (12 Inches)	Cyd	359	$ 13.50	$ 4,846.50
7	HMA Surface	Ton	311	$ 80.00	$ 24,880.00
8	Fire Hydrant Assembly	Ea	3	$ 4,000.00	$ 12,000.00
9	Gate Valve & Box, 16 Inch	Ea	3	$ 6,500.00	$ 19,500.00
10	Water Main, DI, 16 Inch, Tr Det G	Ft	880	$ 200.00	$ 176,000.00
11	Water Service	Ea	12	$ 1,750.00	$ 21,000.00
12	Curb Stop and Box	Ea	12	$ 500.00	$ 6,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	240	$ 5.00	$ 1,200.00
Klock Rd, Water Plant to East Estimate					$ 341,254.50
Contingency				**15%**	$ 51,200.00
Engineering & Construction Administration				**20%**	$ 68,300.00
Total Estimated Water Main Construction Costs					$ 460,754.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: North Shore Dr, Klock Rd to North
Prepared By: Aaron Townley, EIT

North Shore Dr, Klock Rd to North					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 11,300.00	$ 11,300.00
2	Traffic Control	LSum	1	$ 5,400.00	$ 5,400.00
3	Machine Grading	Sta	5.41	$ 1,200.00	$ 6,492.00
4	Pavt, Rem, Modified	Syd	662	$ 9.00	$ 5,958.00
5	Aggregate Base, 8 inch	Syd	662	$ 9.00	$ 5,958.00
6	Subbase, CIP (12 Inches)	Cyd	221	$ 13.50	$ 2,983.50
7	HMA Surface	Ton	191	$ 80.00	$ 15,280.00
8	Fire Hydrant Assembly	Ea	2	$ 4,000.00	$ 8,000.00
9	Gate Valve & Box, 8 Inch	Ea	2	$ 1,750.00	$ 3,500.00
10	Water Main, DI, 8 Inch, Tr Det G	Ft	541	$ 75.00	$ 40,575.00
11	Water Service	Ea	8	$ 1,750.00	$ 14,000.00
12	Curb Stop and Box	Ea	8	$ 500.00	$ 4,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	160	$ 5.00	$ 800.00
North Shore Dr, Klock Rd to North Estimate					$ 124,246.50
Contingency				**15%**	$ 18,700.00
Engineering & Construction Administration				**20%**	$ 24,900.00
Total Estimated Water Main Construction Costs					$ 167,846.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Paw Paw Ave, West of Paw Paw Ave between Waukonda Ave and Frank St
Prepared By: Aaron Townley, EIT

Paw Paw Ave, West of Paw Paw Ave between Waukonda Ave and Frank St					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 18,000.00	$ 18,000.00
2	Traffic Control	LSum	1	$ 8,600.00	$ 8,600.00
3	Machine Grading	Sta	5.3	$ 1,200.00	$ 6,360.00
4	Pavt, Rem, Modified	Syd	648	$ 9.00	$ 5,832.00
5	Aggregate Base, 8 inch	Syd	648	$ 9.00	$ 5,832.00
6	Subbase, CIP (12 Inches)	Cyd	216	$ 13.50	$ 2,916.00
7	HMA Surface	Ton	113	$ 80.00	$ 9,040.00
8	Fire Hydrant Assembly	Ea	2	$ 4,000.00	$ 8,000.00
9	Gate Valve & Box, 16 Inch	Ea	2	$ 6,500.00	$ 13,000.00
10	Water Main, DI, 16 Inch, Tr Det G	Ft	530	$ 200.00	$ 106,000.00
11	Water Service	Ea	6	$ 1,750.00	$ 10,500.00
12	Curb Stop and Box	Ea	6	$ 500.00	$ 3,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	120	$ 5.00	$ 600.00
Paw Paw Ave, West of Paw Paw Ave between Waukonda Ave and Frank St Estimate					$ 197,680.00
Contingency				**15%**	$ 29,700.00
Engineering & Construction Administration				**20%**	$ 39,600.00
Total Estimated Water Main Construction Costs					$ 266,980.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Building Lot (Water St to 2nd St)
Prepared By: Aaron Townley, EIT

Building Lot (Water St to 2nd St)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 12,000.00	$ 12,000.00
2	Traffic Control	LSum	1	$ 5,700.00	$ 5,700.00
3	Machine Grading	Sta	4.88	$ 1,200.00	$ 5,856.00
4	Pavt, Rem, Modified	Syd	597	$ 9.00	$ 5,373.00
5	Aggregate Base, 8 inch	Syd	597	$ 9.00	$ 5,373.00
6	Subbase, CIP (12 Inches)	Cyd	199	$ 13.50	$ 2,686.50
7	HMA Surface	Ton	104	$ 80.00	$ 8,320.00
8	Fire Hydrant Assembly	Ea	2	$ 4,000.00	$ 8,000.00
9	Gate Valve & Box, 12 Inch	Ea	2	$ 2,750.00	$ 5,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	488	$ 125.00	$ 61,000.00
11	Water Service	Ea	5	$ 1,750.00	$ 8,750.00
12	Curb Stop and Box	Ea	5	$ 500.00	$ 2,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	100	$ 5.00	$ 500.00
Building Lot (Water St to 2nd St) Estimate					$ 131,558.50
Contingency				**15%**	$ 19,800.00
Engineering & Construction Administration				**20%**	$ 26,400.00
Total Estimated Water Main Construction Costs					$ 177,758.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Maple St (Pipestone St to Cedar St)
Prepared By: Aaron Townley, EIT

Maple St (Pipestone St to Cedar St)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 13,500.00	$ 13,500.00
2	Traffic Control	LSum	1	$ 6,500.00	$ 6,500.00
3	Machine Grading	Sta	7.32	$ 1,200.00	$ 8,784.00
4	Pavt, Rem, Modified	Syd	895	$ 9.00	$ 8,055.00
5	Aggregate Base, 8 inch	Syd	895	$ 9.00	$ 8,055.00
6	Subbase, CIP (12 Inches)	Cyd	299	$ 13.50	$ 4,036.50
7	HMA Surface	Ton	156	$ 80.00	$ 12,480.00
8	Fire Hydrant Assembly	Ea	2	$ 4,000.00	$ 8,000.00
9	Gate Valve & Box, 8 Inch	Ea	3	$ 1,750.00	$ 5,250.00
10	Water Main, DI, 8 Inch, Tr Det G	Ft	732	$ 75.00	$ 54,900.00
11	Water Service	Ea	8	$ 1,750.00	$ 14,000.00
12	Curb Stop and Box	Ea	8	$ 500.00	$ 4,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	160	$ 5.00	$ 800.00
Maple St (Pipestone St to Cedar St) Estimate					$ 148,360.50
Contingency				**15%**	$ 22,300.00
Engineering & Construction Administration				**20%**	$ 29,700.00
Total Estimated Water Main Construction Costs					$ 200,360.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Riverview Dr and River St
Prepared By: Aaron Townley, EIT

Riverview Dr and River St					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 9,700.00	$ 9,700.00
2	Traffic Control	LSum	1	$ 4,600.00	$ 4,600.00
3	Machine Grading	Sta	2.67	$ 1,200.00	$ 3,204.00
4	Pavt, Rem, Modified	Syd	327	$ 9.00	$ 2,943.00
5	Aggregate Base, 8 inch	Syd	327	$ 9.00	$ 2,943.00
6	Subbase, CIP (12 Inches)	Cyd	109	$ 13.50	$ 1,471.50
7	HMA Surface	Ton	95	$ 80.00	$ 7,600.00
8	Fire Hydrant Assembly	Ea	1	$ 4,000.00	$ 4,000.00
9	Gate Valve & Box, 16 Inch	Ea	1	$ 6,500.00	$ 6,500.00
10	Water Main, DI, 16 Inch, Tr Det G	Ft	267	$ 200.00	$ 53,400.00
11	Water Service	Ea	4	$ 1,750.00	$ 7,000.00
12	Curb Stop and Box	Ea	4	$ 500.00	$ 2,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	80	$ 5.00	$ 400.00
Riverview Dr and River St Estimate					$ 105,761.50
Contingency				**15%**	$ 15,900.00
Engineering & Construction Administration				**20%**	$ 21,200.00
Total Estimated Water Main Construction Costs					$ 142,861.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: 9th St, Britain Ave to South
Prepared By: Aaron Townley, EIT

9th St, Britain Ave to South					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 15,400.00	$ 15,400.00
2	Traffic Control	LSum	1	$ 7,300.00	$ 7,300.00
3	Machine Grading	Sta	6.39	$ 1,200.00	$ 7,668.00
4	Pavt, Rem, Modified	Syd	781	$ 9.00	$ 7,029.00
5	Aggregate Base, 8 inch	Syd	781	$ 9.00	$ 7,029.00
6	Subbase, CIP (12 Inches)	Cyd	261	$ 13.50	$ 3,523.50
7	HMA Surface	Ton	136	$ 80.00	$ 10,880.00
8	Fire Hydrant Assembly	Ea	2	$ 4,000.00	$ 8,000.00
9	Gate Valve & Box, 12 Inch	Ea	2	$ 2,750.00	$ 5,500.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	639	$ 125.00	$ 79,875.00
11	Water Service	Ea	7	$ 1,750.00	$ 12,250.00
12	Curb Stop and Box	Ea	7	$ 500.00	$ 3,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	140	$ 5.00	$ 700.00
9th St, Britain Ave to South Estimate					$ 168,654.50
Contingency				**15%**	$ 25,300.00
Engineering & Construction Administration				**20%**	$ 33,800.00
Total Estimated Water Main Construction Costs					$ 227,754.50

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Brunson Ave (Hornack Rd to Jefferson St)
Prepared By: Aaron Townley, EIT

Brunson Ave (Hornack Rd to Jefferson St)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 12,100.00	$ 12,100.00
2	Traffic Control	LSum	1	$ 5,800.00	$ 5,800.00
3	Machine Grading	Sta	6.57	$ 1,200.00	$ 7,884.00
4	Pavt, Rem, Modified	Syd	803	$ 9.00	$ 7,227.00
5	Aggregate Base, 8 inch	Syd	803	$ 9.00	$ 7,227.00
6	Subbase, CIP (12 Inches)	Cyd	268	$ 13.50	$ 3,618.00
7	HMA Surface	Ton	140	$ 80.00	$ 11,200.00
8	Fire Hydrant Assembly	Ea	2	$ 4,000.00	$ 8,000.00
9	Gate Valve & Box, 8 Inch	Ea	2	$ 1,750.00	$ 3,500.00
10	Water Main, DI, 8 Inch, Tr Det G	Ft	657	$ 75.00	$ 49,275.00
11	Water Service	Ea	7	$ 1,750.00	$ 12,250.00
12	Curb Stop and Box	Ea	7	$ 500.00	$ 3,500.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	140	$ 5.00	$ 700.00
Brunson Ave (Hornack Rd to Jefferson St) Estimate					$ 132,281.00
Contingency				**15%**	$ 19,900.00
Engineering & Construction Administration				**20%**	$ 26,500.00
Total Estimated Water Main Construction Costs					$ 178,681.00

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Project Name: Benton Harbor Water Asset Management Plan
Project Location: Weld St (Union St to Agard Ave)
Prepared By: Aaron Townley, EIT

Weld St (Union St to Agard Ave)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 6,200.00	$ 6,200.00
2	Traffic Control	LSum	1	$ 3,000.00	$ 3,000.00
3	Machine Grading	Sta	3.3	$ 1,200.00	$ 3,960.00
4	Pavt, Rem, Modified	Syd	404	$ 9.00	$ 3,636.00
5	Aggregate Base, 8 inch	Syd	404	$ 9.00	$ 3,636.00
6	Subbase, CIP (12 Inches)	Cyd	135	$ 13.50	$ 1,822.50
7	HMA Surface	Ton	70	$ 80.00	$ 5,600.00
8	Fire Hydrant Assembly	Ea	1	$ 4,000.00	$ 4,000.00
9	Gate Valve & Box, 8 Inch	Ea	1	$ 1,750.00	$ 1,750.00
10	Water Main, DI, 8 Inch, Tr Det G	Ft	330	$ 75.00	$ 24,750.00
11	Water Service	Ea	4	$ 1,750.00	$ 7,000.00
12	Curb Stop and Box	Ea	4	$ 500.00	$ 2,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	80	$ 5.00	$ 400.00
Weld St (Union St to Agard Ave) Estimate					$ 67,754.50
Contingency				**15%**	$ 10,200.00
Engineering & Construction Administration				**20%**	$ 13,600.00
Total Estimated Water Main Construction Costs					$ 91,554.50

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Benton Harbor, MI 49023
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Project Name: Benton Harbor Water Asset Management Plan
Project Location: 4th St (Territorial Rd to Main St)
Prepared By: Aaron Townley, EIT

4th St (Territorial Rd to Main St)					
#	Item Description	Unit	Quantity	Unit Price	Total
1	Mobilization	LSum	1	$ 6,700.00	$ 6,700.00
2	Traffic Control	LSum	1	$ 3,200.00	$ 3,200.00
3	Machine Grading	Sta	2.45	$ 1,200.00	$ 2,940.00
4	Pavt, Rem, Modified	Syd	300	$ 9.00	$ 2,700.00
5	Aggregate Base, 8 inch	Syd	300	$ 9.00	$ 2,700.00
6	Subbase, CIP (12 Inches)	Cyd	100	$ 13.50	$ 1,350.00
7	HMA Surface	Ton	87	$ 80.00	$ 6,960.00
8	Fire Hydrant Assembly	Ea	1	$ 4,000.00	$ 4,000.00
9	Gate Valve & Box, 12 Inch	Ea	1	$ 2,750.00	$ 2,750.00
10	Water Main, DI, 12 Inch, Tr Det G	Ft	245	$ 125.00	$ 30,625.00
11	Water Service	Ea	4	$ 1,750.00	$ 7,000.00
12	Curb Stop and Box	Ea	4	$ 500.00	$ 2,000.00
13	Restoration (Grass, Seed, & Topsoil)	Syd	80	$ 5.00	$ 400.00
4th St (Territorial Rd to Main St) Estimate					$ 73,325.00
Contingency				**15%**	$ 11,000.00
Engineering & Construction Administration				**20%**	$ 14,700.00
Total Estimated Water Main Construction Costs					$ 99,025.00

APPENDIX G

BENTON HARBOR WATER SYSTEM

CASH FLOW

City of Benton Harbor, Michigan

Historical and Projected Water System Operating Cash Flow and Debt Service Coverage
Fiscal Years Ended or Ending June 30, 2014 Through 2037

	2014 (1)	2015 (1)	2016 (1)	Preliminary 2017 (2)	Projected 2018 (2)	Project 2019
Operating Revenues						
Water RTS/Commodity	$ 1,854,525	$ 2,028,776	$ 1,970,829	$ 1,631,024	$ 1,631,024	$ 1,6
Water Capital Charge		-	-	253,385	253,385	2
Sprinkler, Hydrant, Fire		-	-	37,333	37,333	
Other		-	-	32,540	32,540	
Fines	17,160	177	-	20,340	20,340	
Total Operating Revenues	$ 1,871,685	$ 2,028,953	$ 1,970,829	$ 1,974,622	$ 1,974,622	$ 1,9
Operating Expenses (4)						
Utility Administration	$ 564,359	$ 416,835	$ 487,463	$ 570,662	$ -	$
Customer Service	178,106	63,627	54,432	51,079	-	
Water Treatment	721,683	414,240	457,036	408,751	-	
Water Distribution	893,856	554,709	585,567	622,208	-	
Other	8,994	5,138	5,336	-	-	
Depreciation	306,949	296,727	299,373	-	-	
Total Operating Expenses	$ 2,673,947	$ 1,751,275	$ 1,889,207	$ 1,652,700	$ 1,702,281	$ 1,7
Operating Income (Loss)	$ (802,262)	$ 277,678	$ 81,623	$ 321,922	$ 272,341	$ 2
Non-Operating Revenues (Expenses)						
Interest Income	$ -	$ -	$ -	$ -	$ -	$
State Grants/FDCVT Proceeds	-	185,108	194,777	300,000	-	
Gain from sale of capital assets	-	-	2,309	-	-	
Repayment of federal debt previously forgiven	(141,358)	-	-	-	-	
Income From Joint Venture	153,247	172,888	(40,562)	-	-	
Depreciation	306,949	296,727	299,373	-	-	
Total Non-Operating Revenues (Expenses)	$ 318,838	$ 654,722	$ 455,896	$ 300,000	$ -	$
NET INCOME AVAILABLE FOR DEBT SERVICE	$ (483,425)	$ 932,400	$ 537,519	$ 621,922	$ 272,341	$ 2
Debt Service Requirements						
Drinking Water Revolving Fund Revenue Bonds, Series 2009	$ 11,125	$ 8,105	$ 7,980	$ 7,855	$ 7,730	$
Drinking Water Revolving Fund Revenue Bonds, Series 2010	410,375	410,250	410,000	409,625	414,125	4
Water Storage Projects						
Water Supply Projects						
Water Distribution Projects						
Water Supply System Revenue Bonds, Series 2018, for SAW	-	-	-	-	-	
Water Supply System Revenue Bonds, Series 2023, for SAW						
Total	$ 421,500	$ 418,355	$ 417,980	$ 417,480	$ 421,855	$ 4
Debt Service Coverage Ratio	**(1.15x)**	**2.23x**	**1.29x**	**1.49x**	**0.65x**	

(3)	Projected 2025	(3)	Projected 2026	(3)	Projected 2027	(3)	Projected 2028	(3)	Projected 2029	(3)	Projected 2030	(3)	Projected 2031	(3)	Projected 2032	(3)
	$ 1,631,024		$ 1,631,024		$ 1,631,024		$ 1,631,024		$ 1,631,024		$ 1,631,024		$ 1,631,024		$ 1,631,024	
	253,385		253,385		253,385		253,385		253,385		253,385		253,385		253,385	
	37,333		37,333		37,333		37,333		37,333		37,333		37,333		37,333	
	32,540		32,540		32,540		32,540		32,540		32,540		32,540		32,540	
	20,340		20,340		20,340		20,340		20,340		20,340		20,340		20,340	
	$ 1,974,622		$ 1,974,622		$ 1,974,622		$ 1,974,622		$ 1,974,622		$ 1,974,622		$ 1,974,622		$ 1,974,622	
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	
	-		-		-		-		-		-		-		-	
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	-		-		-		-		-		-		-		-	
	-		-		-		-		-		-		-		-	
	$ 1,915,932		$ 1,915,932		$ 1,915,932		$ 1,915,932		$ 1,915,932		$ 1,915,932		$ 1,915,932		$ 1,915,932	
	$ 58,690		$ 58,690		$ 58,690		$ 58,690		$ 58,690		$ 58,690		$ 58,690		$ 58,690	
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	
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	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	
	$ 58,690		$ 58,690		$ 58,690		$ 58,690		$ 58,690		$ 58,690		$ 58,690		$ 58,690	
	$ 6,855		$ 6,730		$ 6,605		$ 6,480		$ 6,355		$ 6,230		$ 6,105		$ 5,980	
	411,000		409,250		412,375		410,250		413,000		410,500		412,875		410,000	
#	15,279	#	15,279	#	15,279	#	15,279	#	15,279	#	15,279	#	15,279	#	15,279	#
#	47,777	#	47,777	#	47,777	#	47,777	#	47,777	#	47,777	#	47,777	#	47,777	#
#	691,765	#	691,765	#	691,765	#	691,765	#	691,765	#	691,765	#	691,765	#	691,765	
	43,987		43,512		43,037		42,562		42,087		41,612		46,137		45,544	
	50,400		49,925		49,450		48,975		48,500		53,025		52,431		51,837	
	$ 1,267,063		$ 1,264,238		$ 1,266,288		$ 1,263,088		$ 1,264,763		$ 1,266,188		$ 1,272,369		$ 1,268,182	
	0.05x		**0.05x**		**0.05x**		**0.05x**		**0.05x**		**0.05x**		**0.05x**		**0.05x**	

Appendix E

Treatment Optimization Recommendations

STATE OF MICHIGAN

JOHN ENGLER, Governor

DEPARTMENT OF PUBLIC HEALTH

3423 N. MARTIN L. KING JR. BLVD.
P.O. BOX 30195, LANSING, MICHIGAN 48909
VERNICE DAVIS ANTHONY, MPH, Director

May 23, 1995

TO: Michigan Surface Water Treatment Plant Operators

Subject: Water Treatment Optimization Practices

Gentlemen/Ladies:

Several weeks ago U.S. EPA administrator Carol Browner outlined in a press conference a voluntary plan aimed at improving the overall effectiveness of surface water treatment facilities. The plan, called "The Partnership for Safe Water," is designed to encourage drinking water utilities to survey their facilities, treatment processes, operating and maintenance procedures, and management oversight practices to identify areas that will enhance the system's ability to prevent the entry of *Cryptosporidium, Giardia,* and other microbial contaminants to treated water. National partners include EPA, the Association of State Drinking Water Administrators, AWWA, the AWWA Research Foundation, the Association of Metropolitan Water Agencies, and the National Association of Water Companies.

In response to the outbreak of *Cryptosporidiosis* in Milwaukee, the Division of Water Supply has set forth practices for water utility officials to follow which should minimize the potential for such an event in Michigan. The attached recommended practices is the product of an ad hoc committee of Michigan water plant superintendents and others knowledgeable of complete water treatment operations. This document parallels in a somewhat condensed manner the goals of the EPA's national partnership plan which some Michigan communities have voluntarily agreed to participate in.

We urge that every surface water treatment plant superintendent and their staff critically examine their respective water treatment operations using the enclosed material as guidance. Should there be any questions about the recommended practices, please contact your district engineer.

Very truly yours,

James K. Cleland

James K. Cleland, P.E., Chief
Division of Water Supply
Bureau of Environmental and
Occupational Health

JKC:MKM
Enclosure

May 16, 1995

SUBJECT: Recommended Practices for Treatment Optimization

OVERVIEW

Increasing awareness of the potentially severe impact of cryptosporidium in drinking water has refocused attention on the importance of optimal water treatment. Because cryptosporidium is resistant to the disinfectants typically used in water treatment plants, it is essential that every effort be made to effect their removal through the pretreatment and filtration processes.

The department has utilized the input of a group of Michigan water treatment plant superintendents to develop recommended practices in four areas: treatment goals, monitoring protocols, treatment optimization, and emergency operating procedures. These treatment practices must be optimized if Michigan water supplies are to continue to avoid the cryptosporidiosis outbreaks experienced in other areas of the country.

TREATMENT GOALS

The goal of all water treatment plants should be to consistently produce finished water turbidities of 0.1 ntu or less.

The goal for each individual filter should be to consistently produce water with turbidities of 0.1 ntu or less.

The goal of plant operators should be to minimize the size and duration of turbidity increases above 0.1 ntu in individual filters after the following:

1) Restarting filters after backwash.
2) Restarting unwashed filters after routine plant shutdown.
3) Changes in filtration rates.
4) Changes in settled water quality.

MONITORING PROTOCOLS

Conformance with the treatment goals outlined above can only be determined if the necessary monitoring information is available. It is recommended that continuously recording turbidimeters be provided for:

1) Raw water.
2) Settled water.
3) Each individual filter.
4) Combined filter effluent.

Where it is not feasible to provide a turbidimeter for each filter, it is recommended that each group or bank of filters be provided with one turbidimeter and the necessary piping and valving to allow for monitoring of a specific filter or the entire group of filters.

It is recommended that particle counters be utilized to determine the effectiveness of optimized treatment. Particle counters have the potential to provide an earlier and more sensitive detection of water quality changes than turbidimeters. It is recommended that settled water and filtered water particle counts be monitored as another indicator of treatment efficiency and to provide a numerical measure of the removal of particles in the 2-5 micron cryptosporidium size range.

Because of the high cost and uncertain reliability of cryptosporidium and giardia testing, the State does not recommend routine testing for these parameters at this time. However, if improvements in methods and reductions in analytical costs occur, this type of monitoring will become useful in evaluating plant performance. Cryptosporidium and giardia testing is currently optional for water utilities and may be useful depending on specific conditions. Such testing may be required in the future by U.S. EPA regulation. The limitations of current laboratory methods can lead to uncertain or unreliable results. As such, utilities which pursue testing must carefully interpret these results. Careful selection of qualified laboratories is also an important factor when considering such testing.

TREATMENT OPTIMIZATION

There is an extensive amount of literature published on the subject of water treatment. A list of selected references pertaining to treatment optimization is attached. Based on a series of meetings with water treatment plant superintendents, a number of treatment practices were identified as being potentially important with regard to cryptosporidium removal, and in achieving the treatment goals listed above.

For coagulant feed control, the following practices should be examined:

1) Routine jar testing.
2) Use of streaming current detectors or other methods for controlling coagulant feed rates.
3) Optimization of the rapid mix and flocculation stages of treatment, including periods when backwash water is recycled.
4) Use of polymers.

The effectiveness of previous coagulant adjustments made in response to adverse changes in raw water quality caused by climatic and hydrologic events should be reviewed.

For filter operation, the following practices should be examined:

1) Filtering to waste following backwash.
2) Adding coagulant directly onto the filter influent following backwash, in the backwash water, or at the end of a backwash.
3) Allowing filters to set for a period of time following backwash before returning to service.
4) Ramping up the flow rate onto any filter being returned to service.
5) Minimizing sudden rate changes on the filters.

6) Comparing length of filter runs and head loss development with filter effluent turbidities.
7) Routine inspections for gravel mounding, mud balls, bed cracking, media growth, and media loss.
8) Checking for even flow distribution during backwash.

Many plants have been shown to operate more effectively from a water quality standpoint if the overall treatment rate is reduced. A reduction in the plant operating rate should be considered whenever monitoring shows degradation of treated water quality. Reductions in rates should also be considered during periods of adverse raw water quality or cold water conditions. It may be necessary to establish a lower overall plant rating than previously set in order to ensure meeting plant treatment goals at all times.

If reclaim of backwash water is part of routine plant operations, extreme care must be given to this practice to ensure against lowering plant effluent quality. Should there be any question about meeting treatment goals as the result of reclaim operations, discontinuing this practice permanently is encouraged.

EMERGENCY OPERATING PROCEDURES

All treatment plants occasionally experience changes in raw water quality that cause treatment goals to be exceeded. Experience has shown that brief periods of ineffective treatment can cause a cryptosporidiosis outbreak. Our discussions with water treatment plant superintendents emphasized the need to review in advance any procedures that may be effective in dealing with adverse changes in water quality. In particular, it was emphasized that information must be shared among operators in a treatment plant so that proper emergency procedures are implemented regardless of the operator on duty. It is recommended that each plant prepare a specific list of procedures for dealing with the various types of adverse treatment conditions that have previously been encountered. Plant staff are encouraged to review past operating history to evaluate the effectiveness of previous responses to these conditions so as to more quickly implement an effective treatment regime.

A number of emergency procedures were emphasized when treatment goals are being exceeded. They include:

1) Temporary plant shutdown.
2) Slowing treatment rates.
3) Stopping reclaim of backwash water.
4) Monitoring individual filter turbidities.
5) Filtering to waste.
6) Hand dosing of coagulant onto filters.
7) Use of anionic or non-ionic polymer filter aids.
8) Increasing disinfectant dose.
9) Increasing monitoring frequencies.

REFERENCES

The following recent articles and/or conferences focused on optimizing water treatment operations. It is strongly recommended that water plant officials review these article and conference outlines to help assess the overall performance of their plants and to better determine what areas of the overall operations and facilities need improvements or corrections.

1. "Assessing Treatment Plant Performance"; William D. Bellamy, John L. Cleasby, Gary S. Logsdon, and Martin J. Allen; Journal AWWA, Vol 85, December 1993, pp. 34-38.

2. "Preventing Waterborne Disease: How to Optimize Treatment", Participant Guide, AWWA Satellite Teleconference, September 9, 1994.

3. "Chicago, Bulls, and Cryptosporidium", AWWARF Technology Transfer Conference, Conference Outline, October 14, 1993.

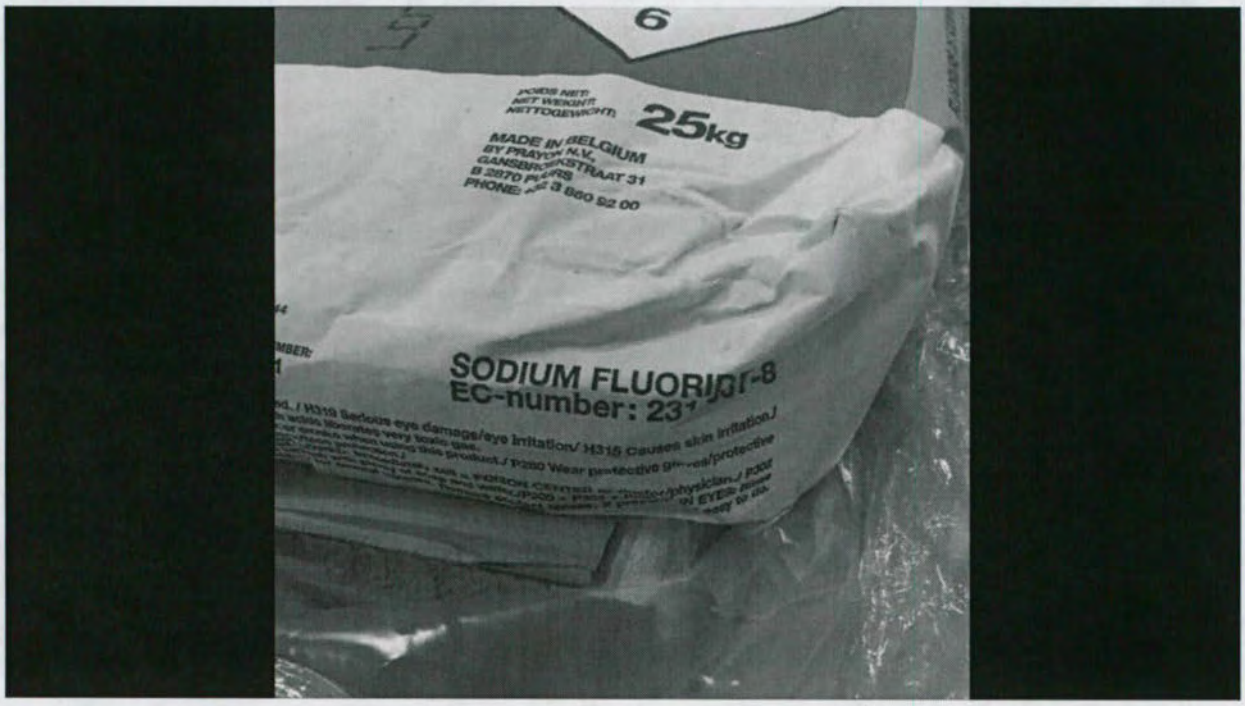
Appendix F

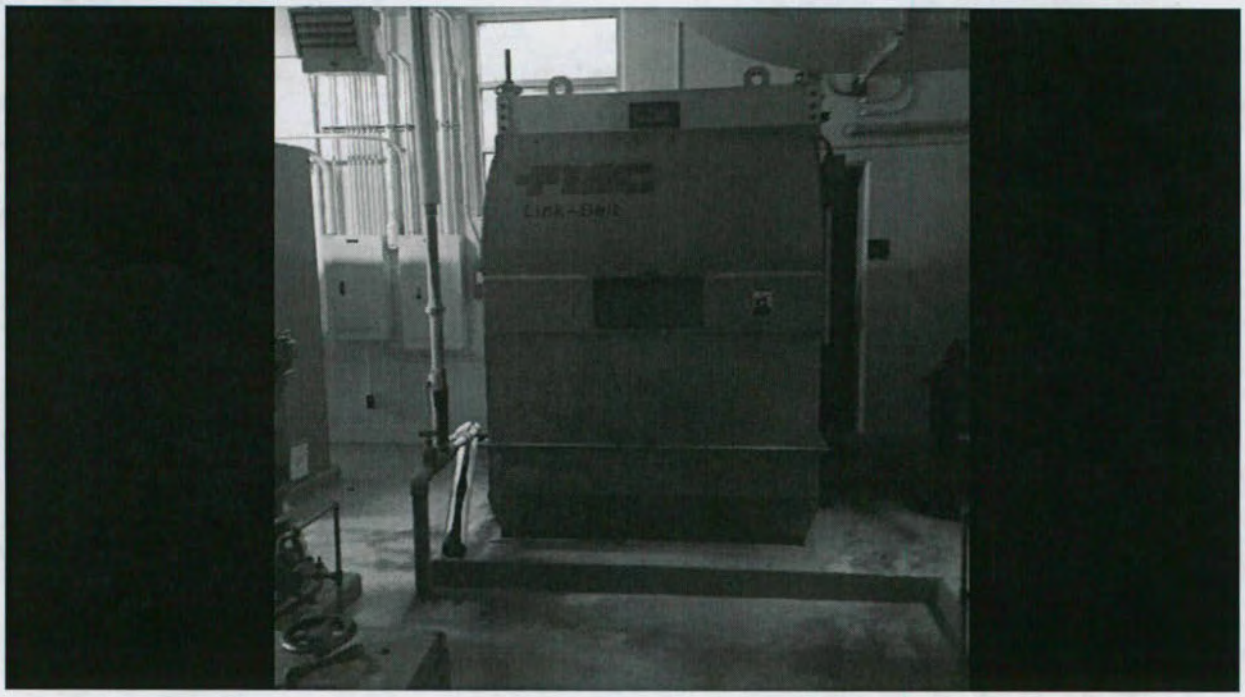
Survey Photos

2018 Sanitary Survey Photos





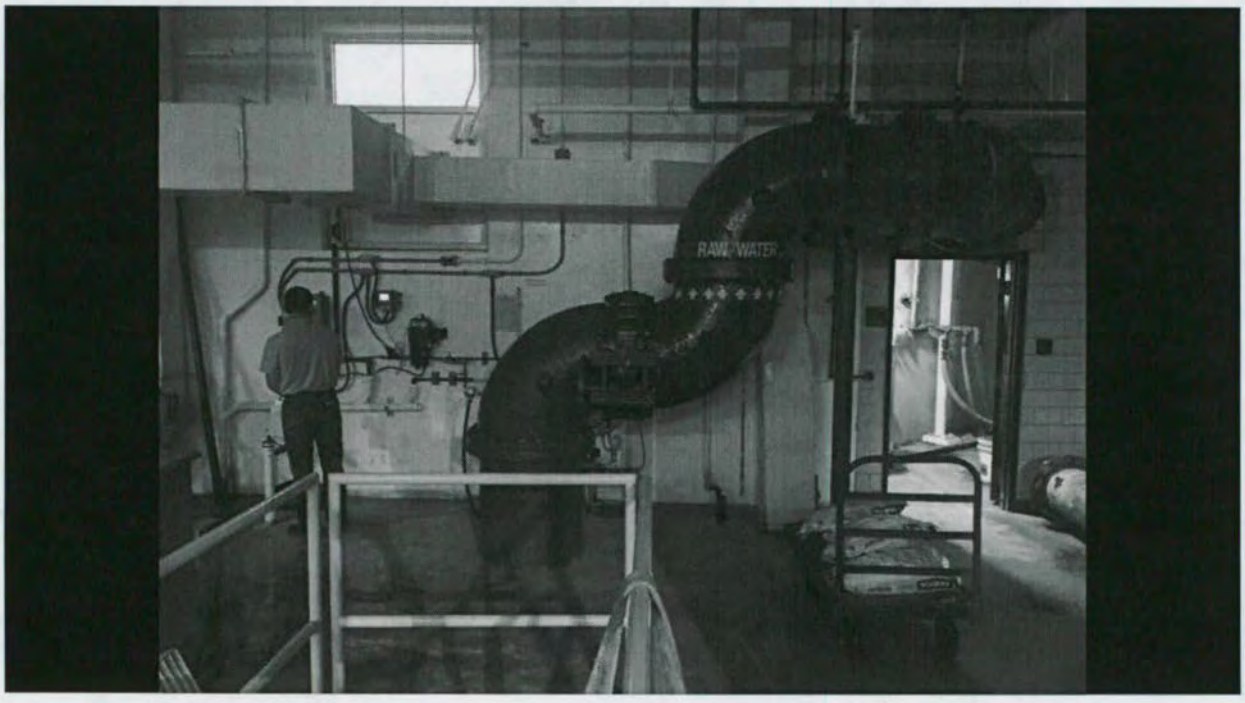

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25kg
MADE IN BELGIUM
SODIUM FLUORIDE-8
EC-number: 231

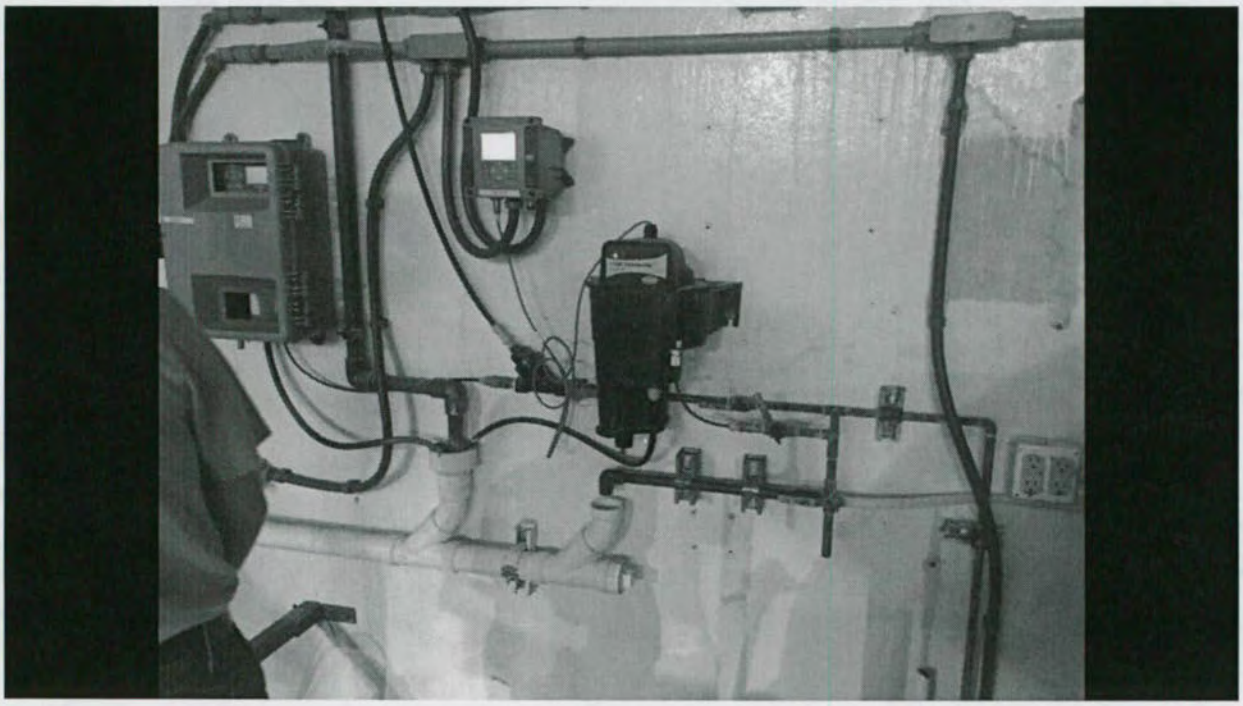


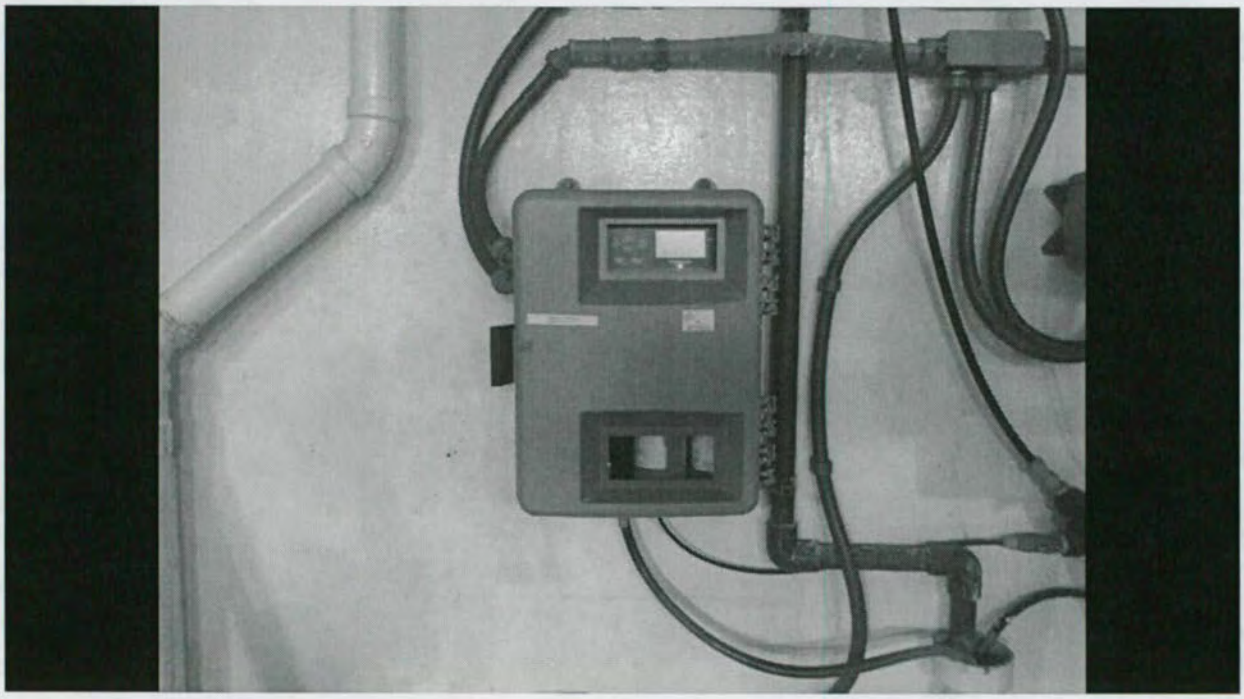


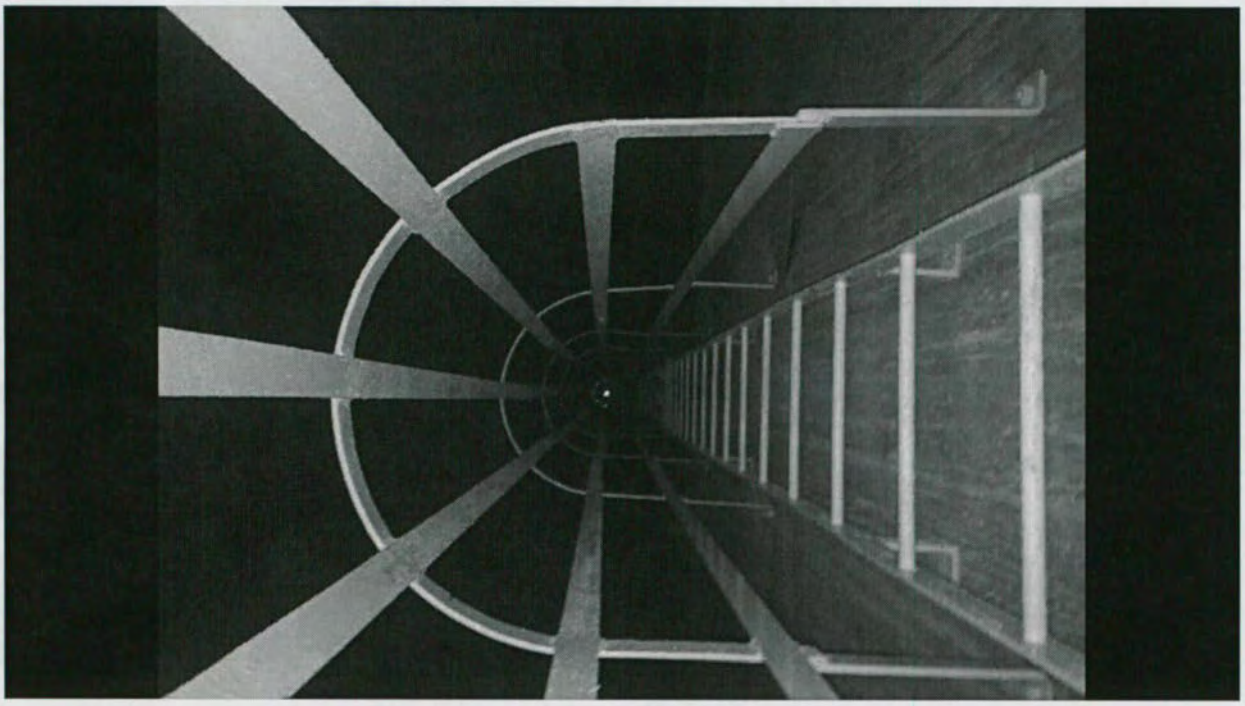





RAW WATER





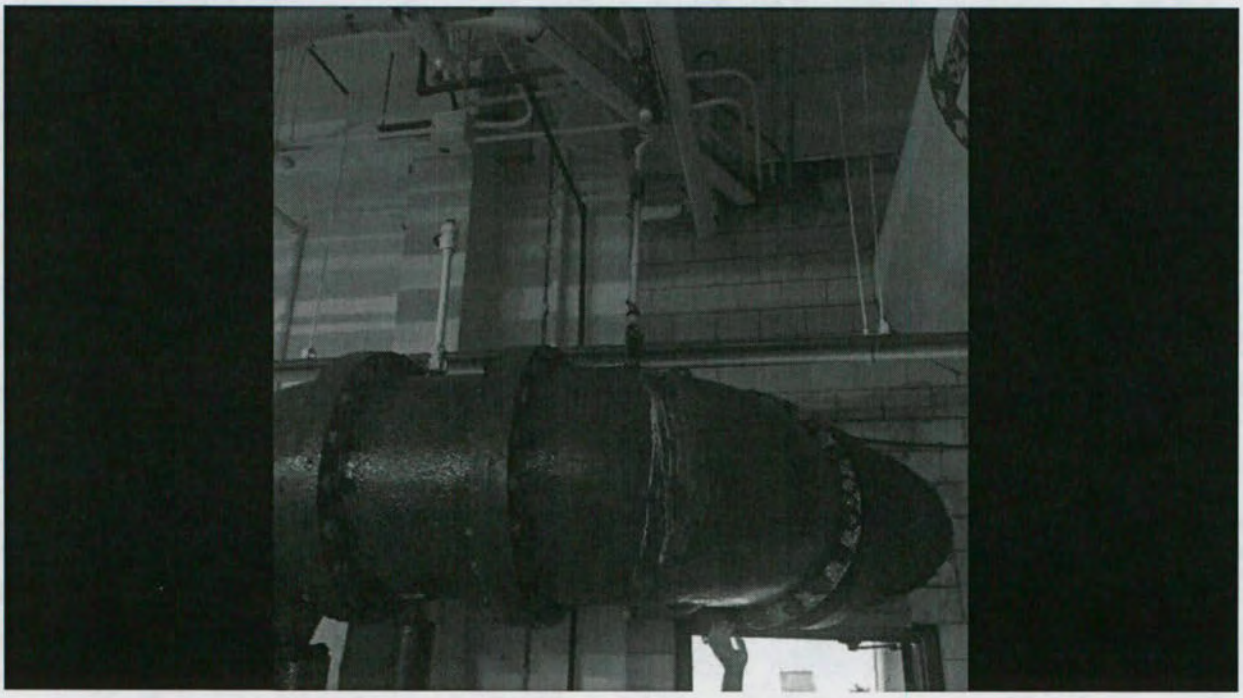


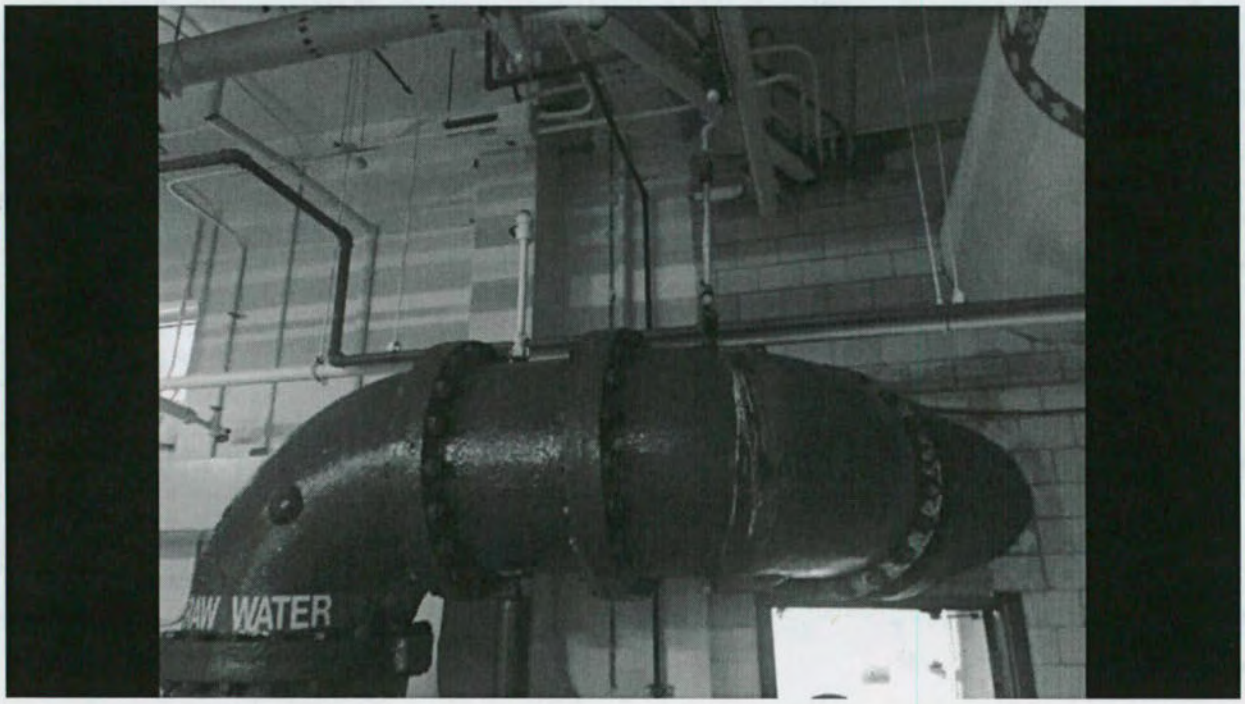





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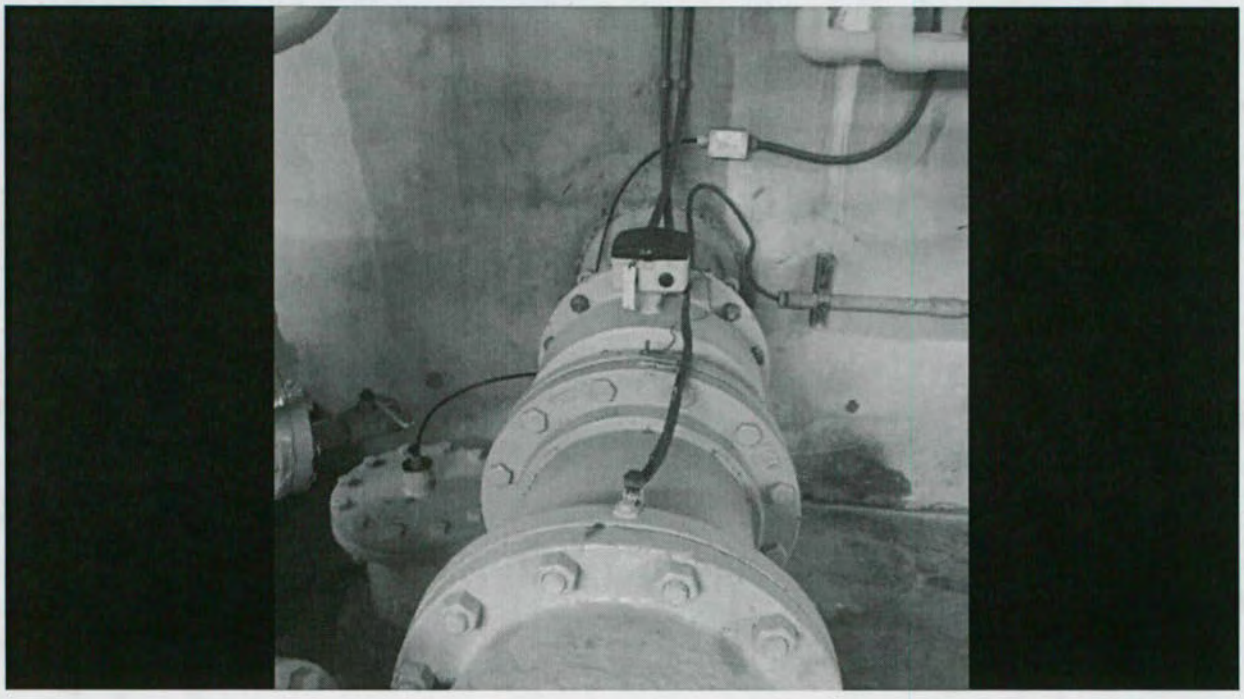


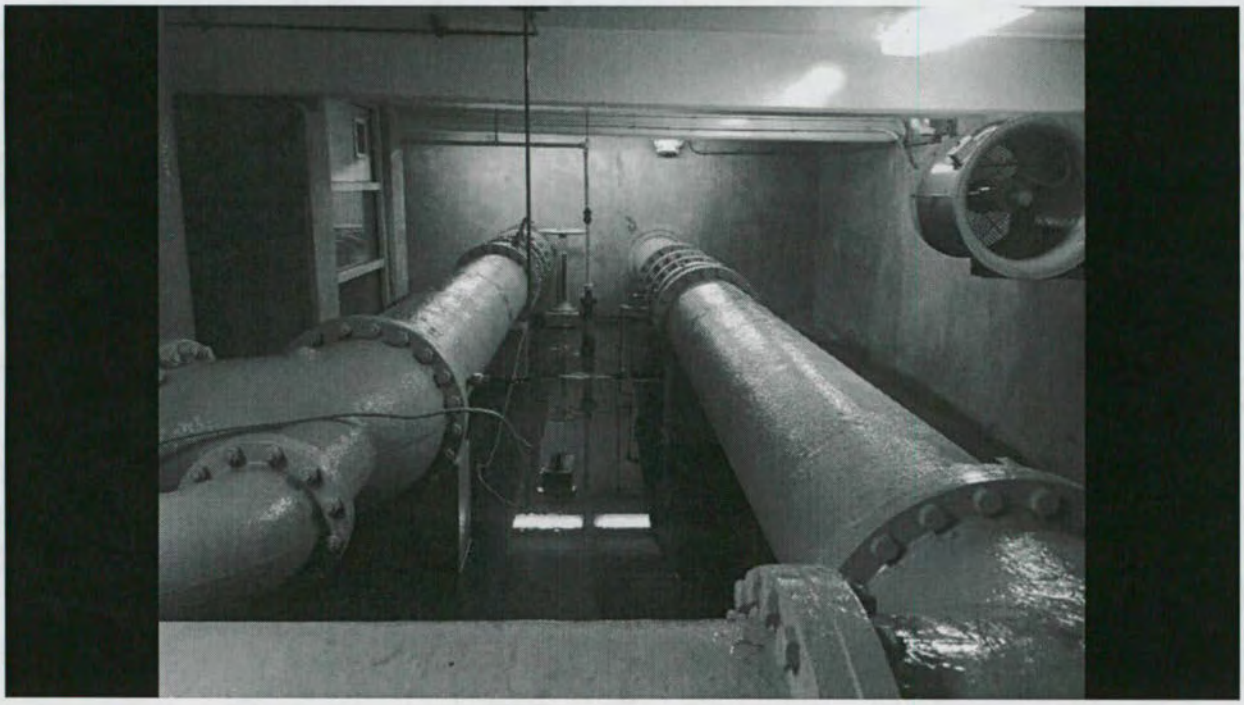


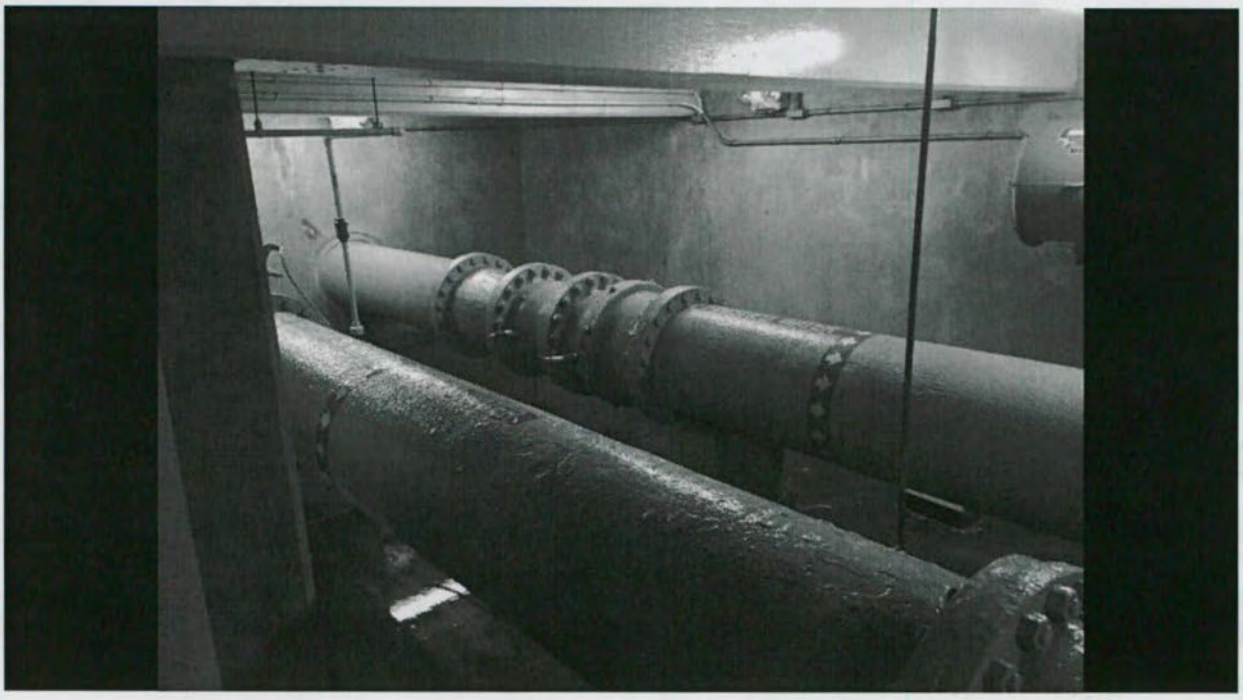

AW WATER

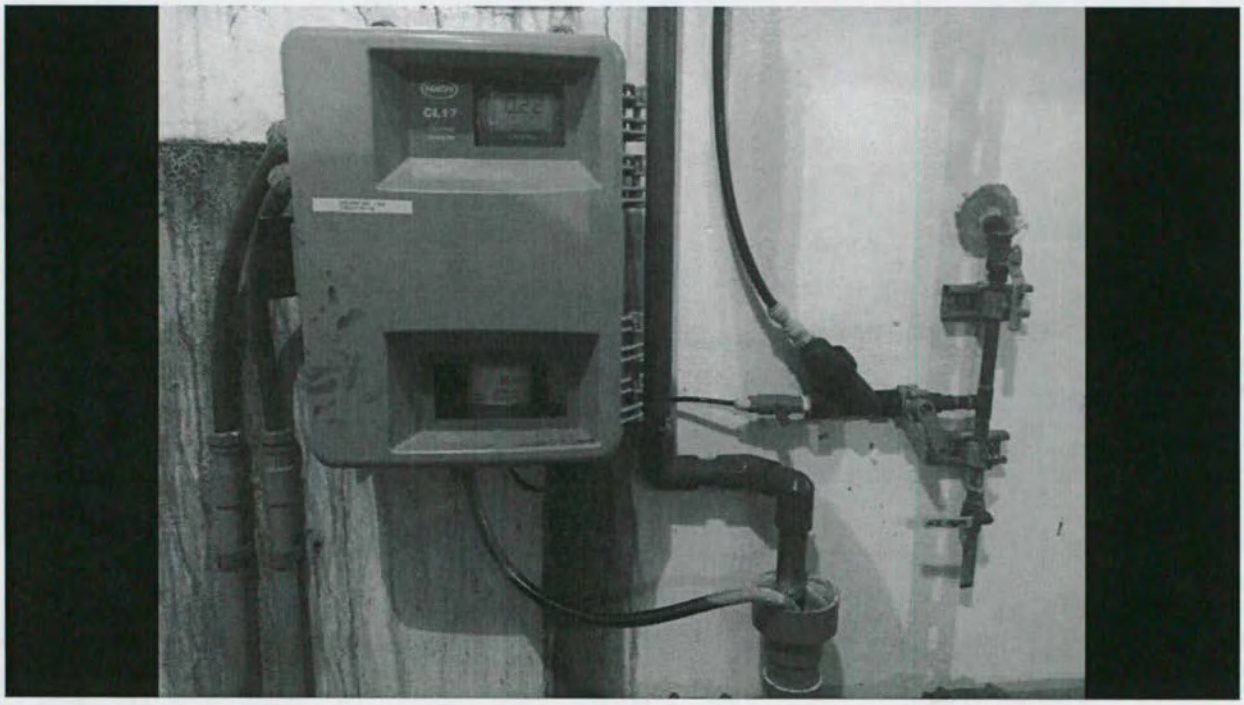


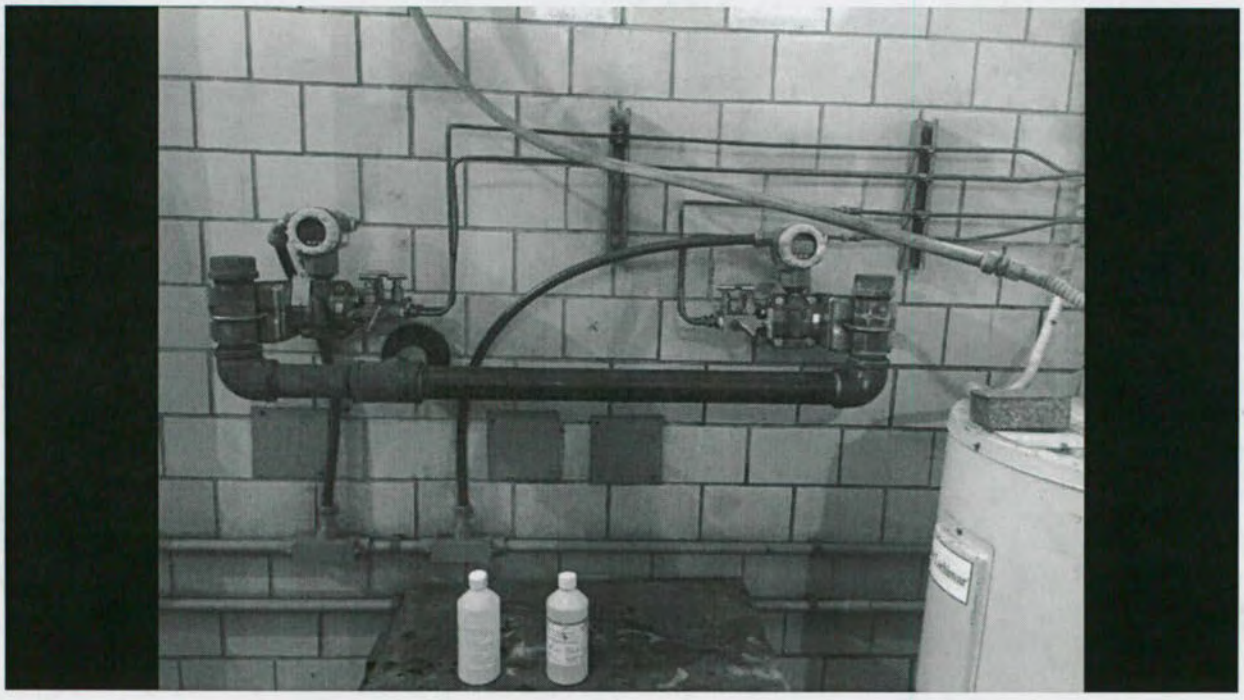


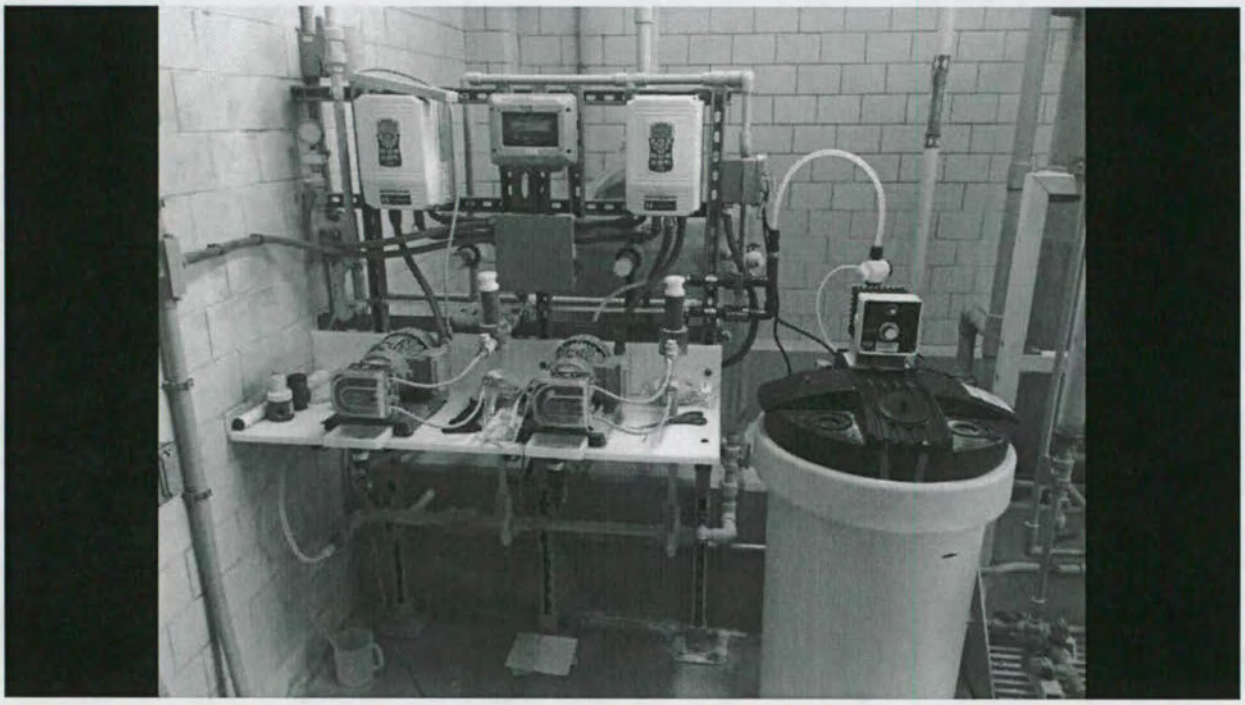


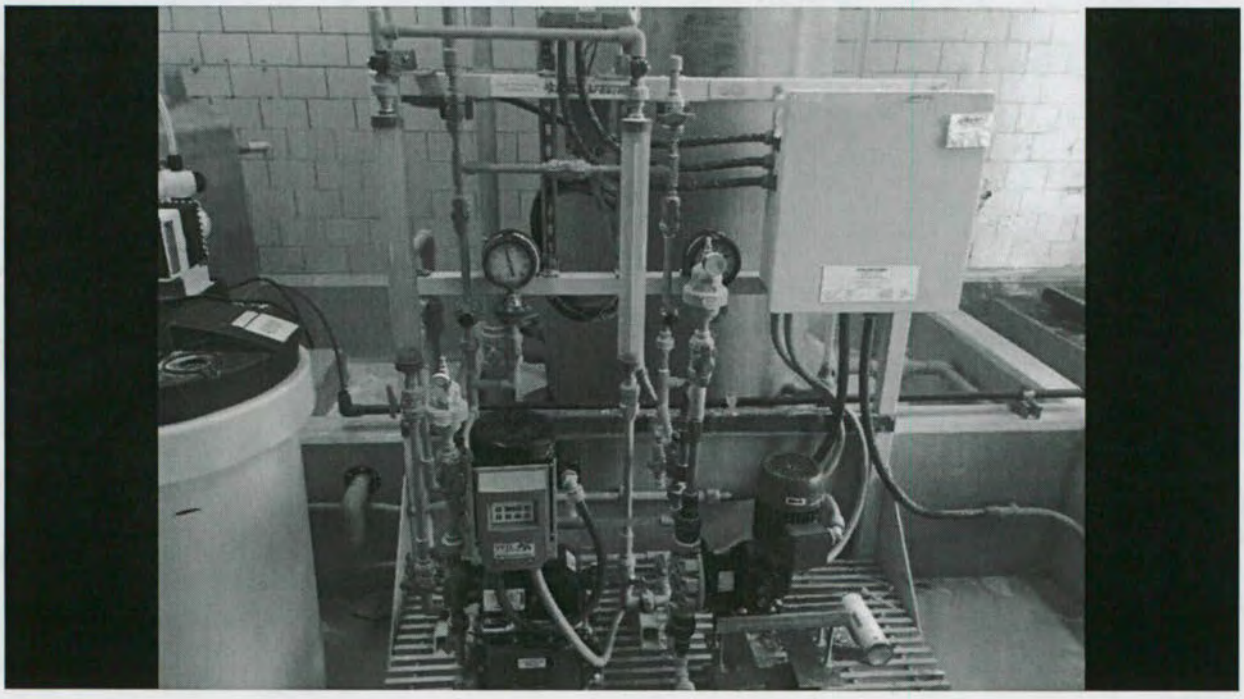


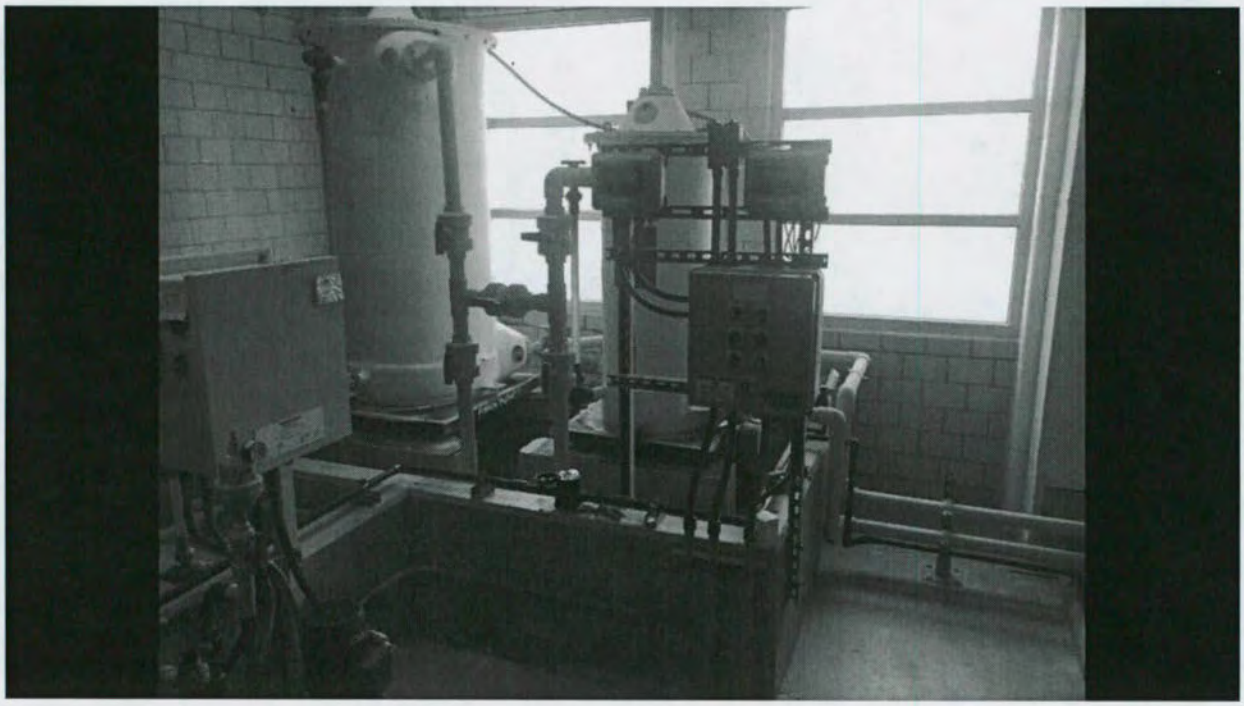


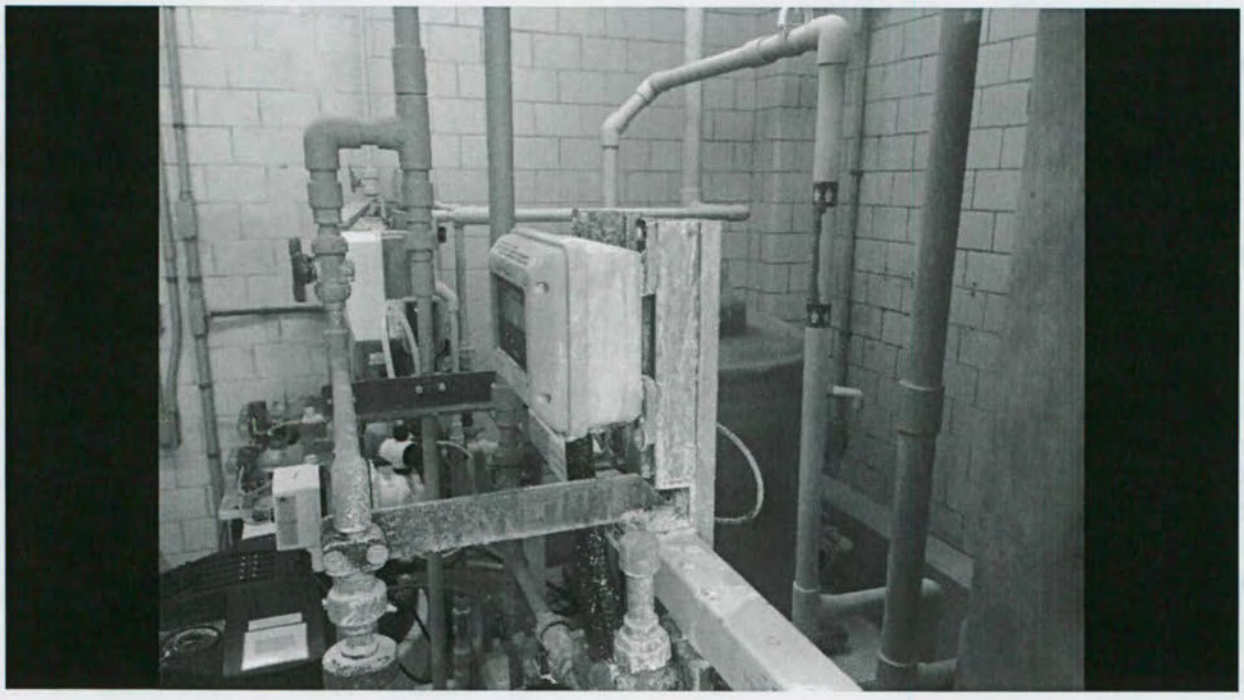

GL17





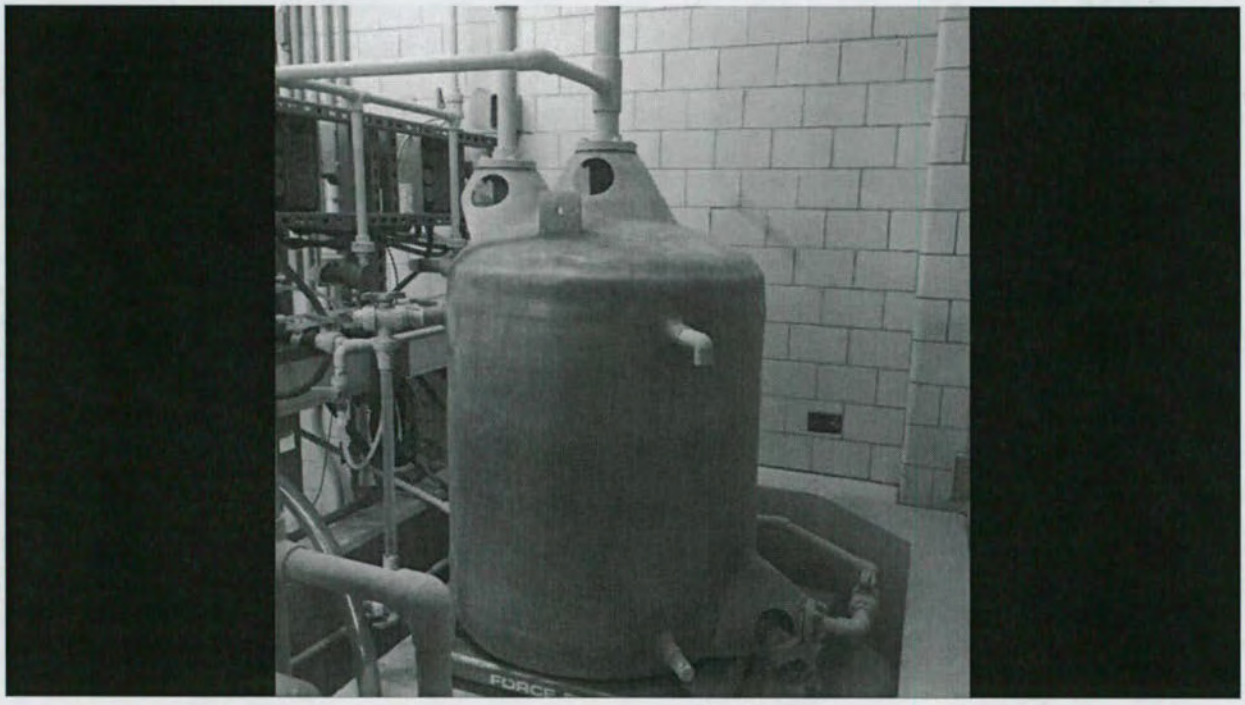




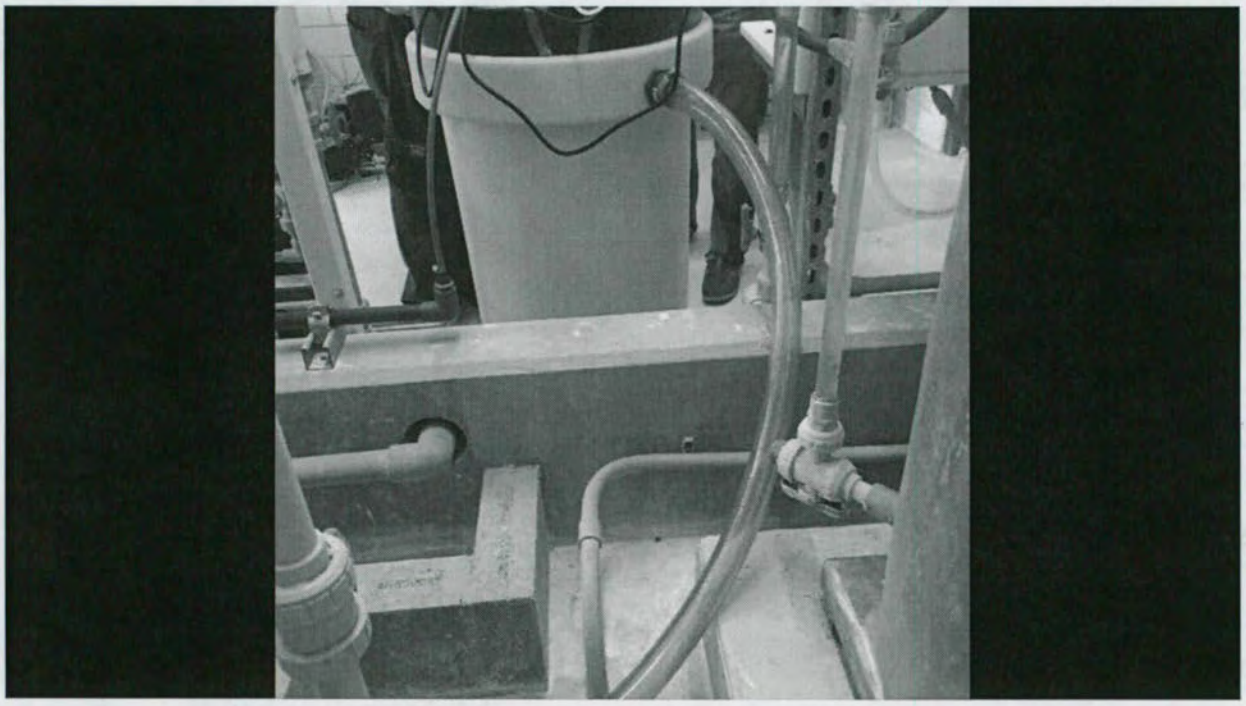


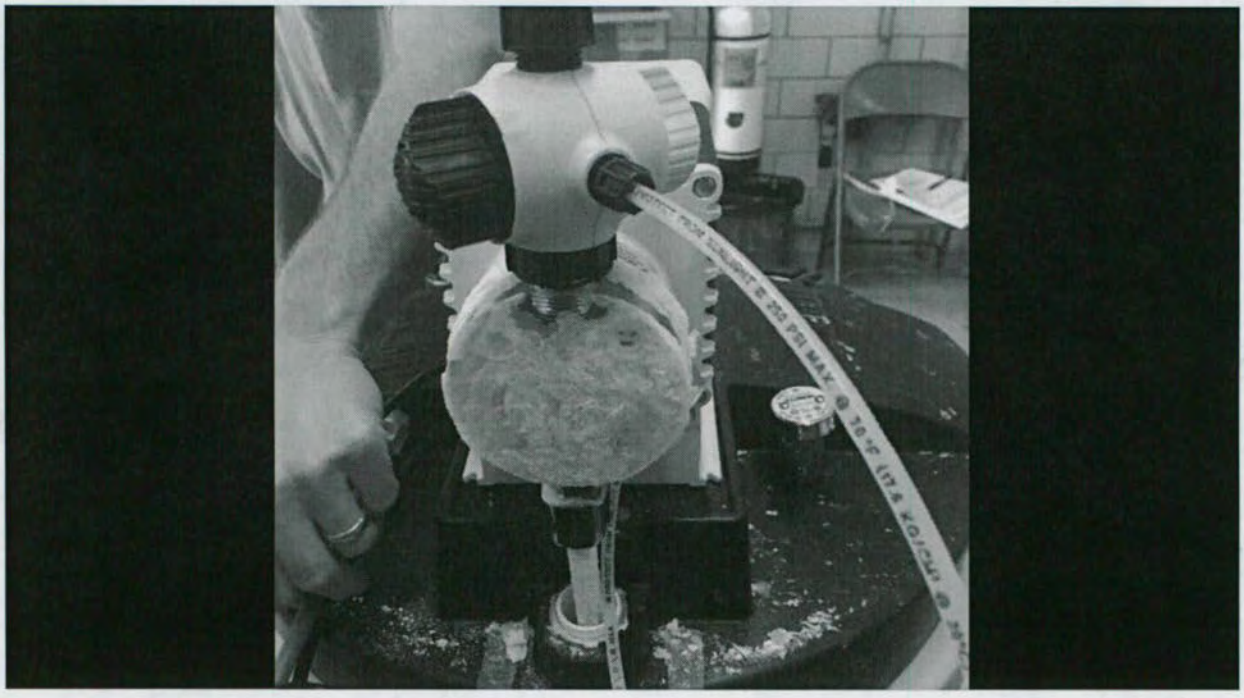


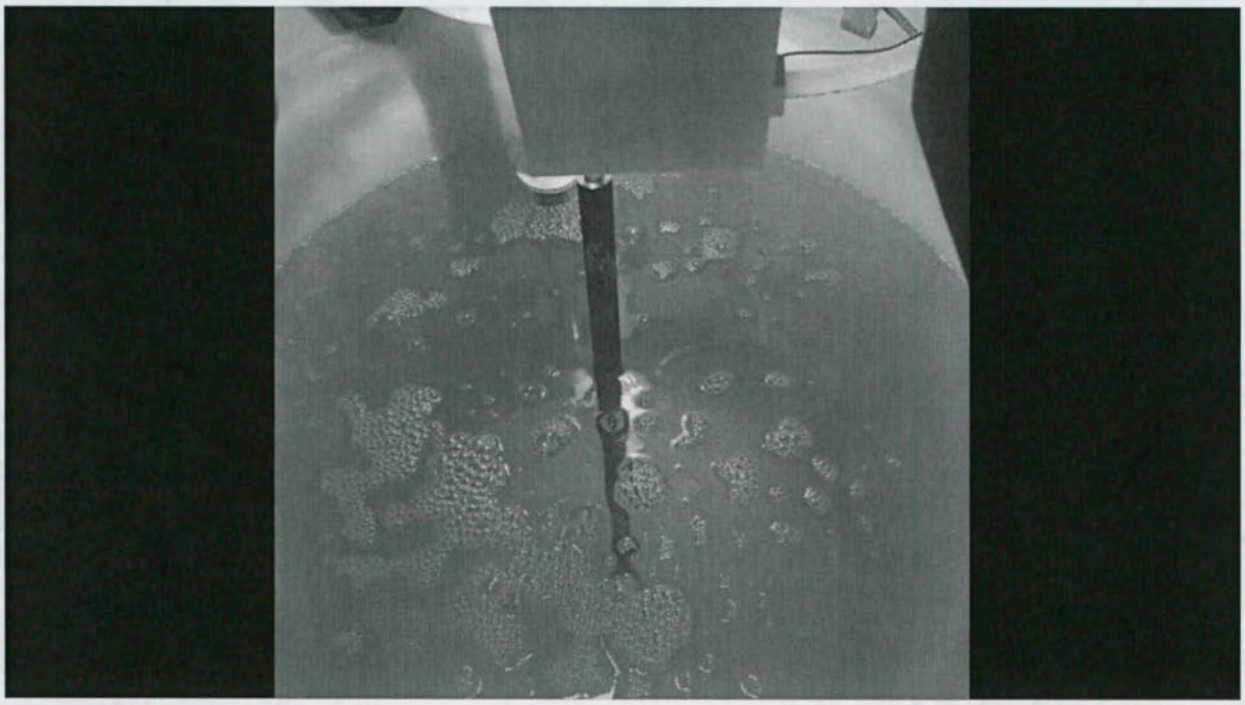

FORCE FLOW

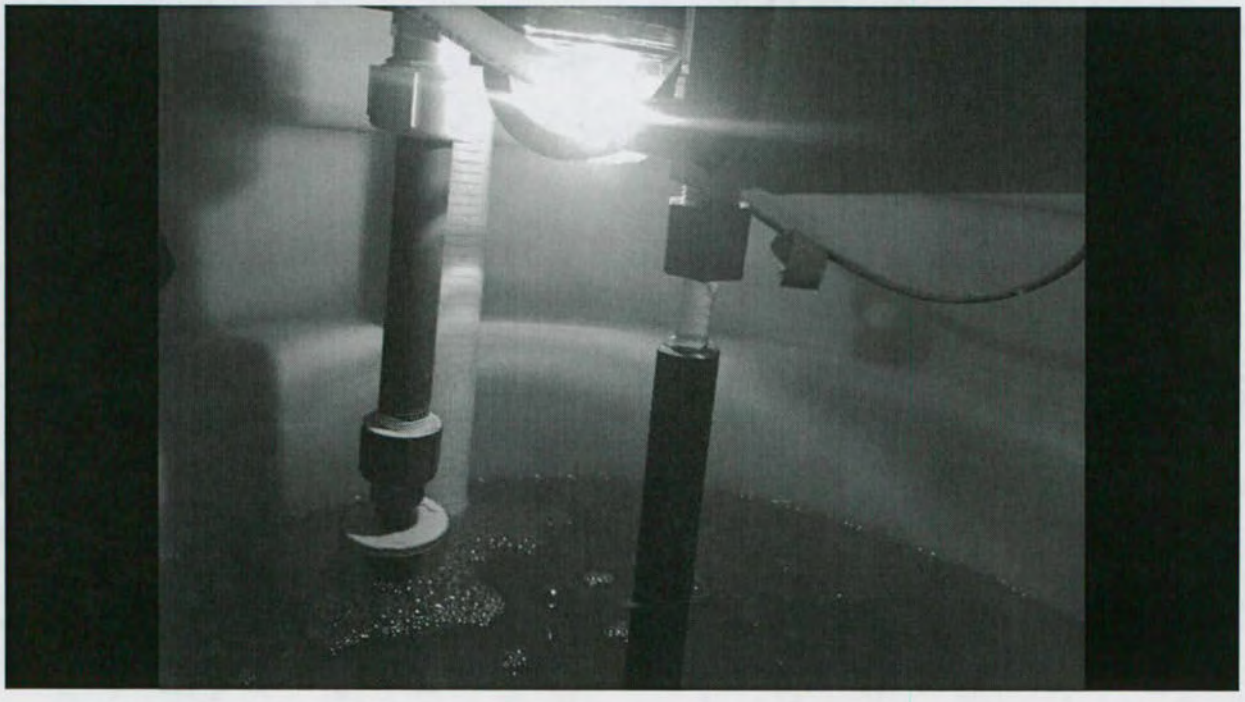


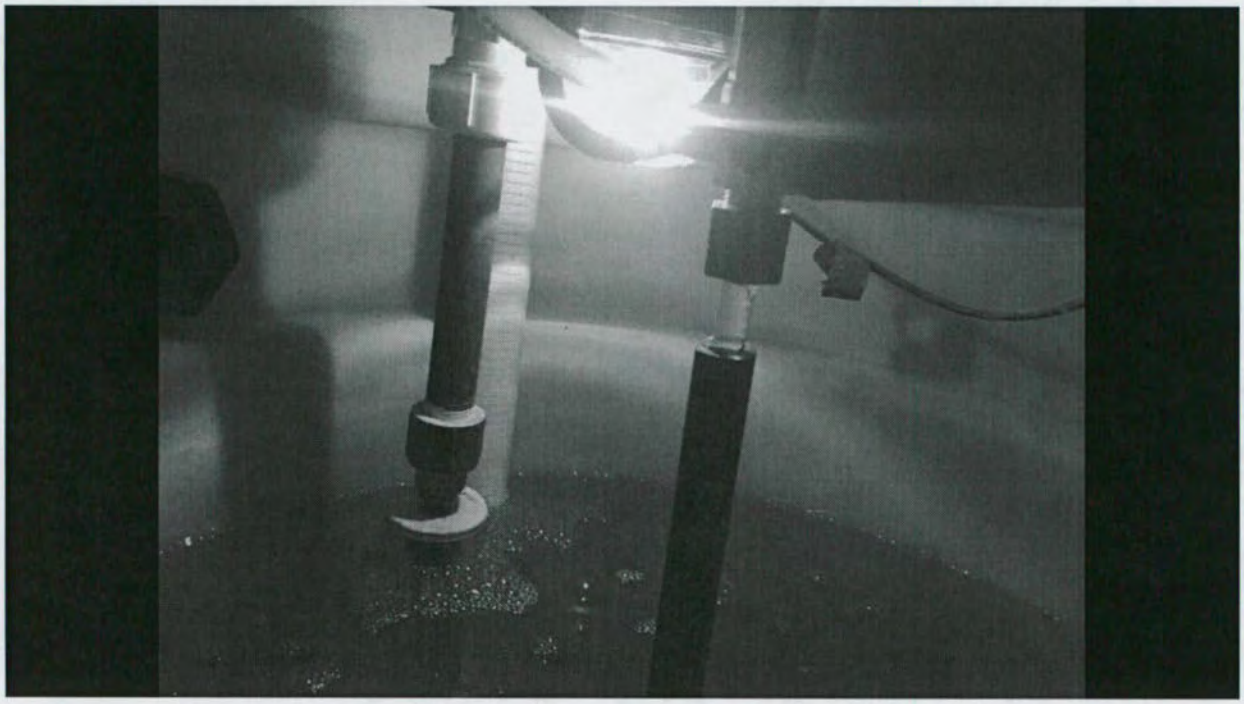




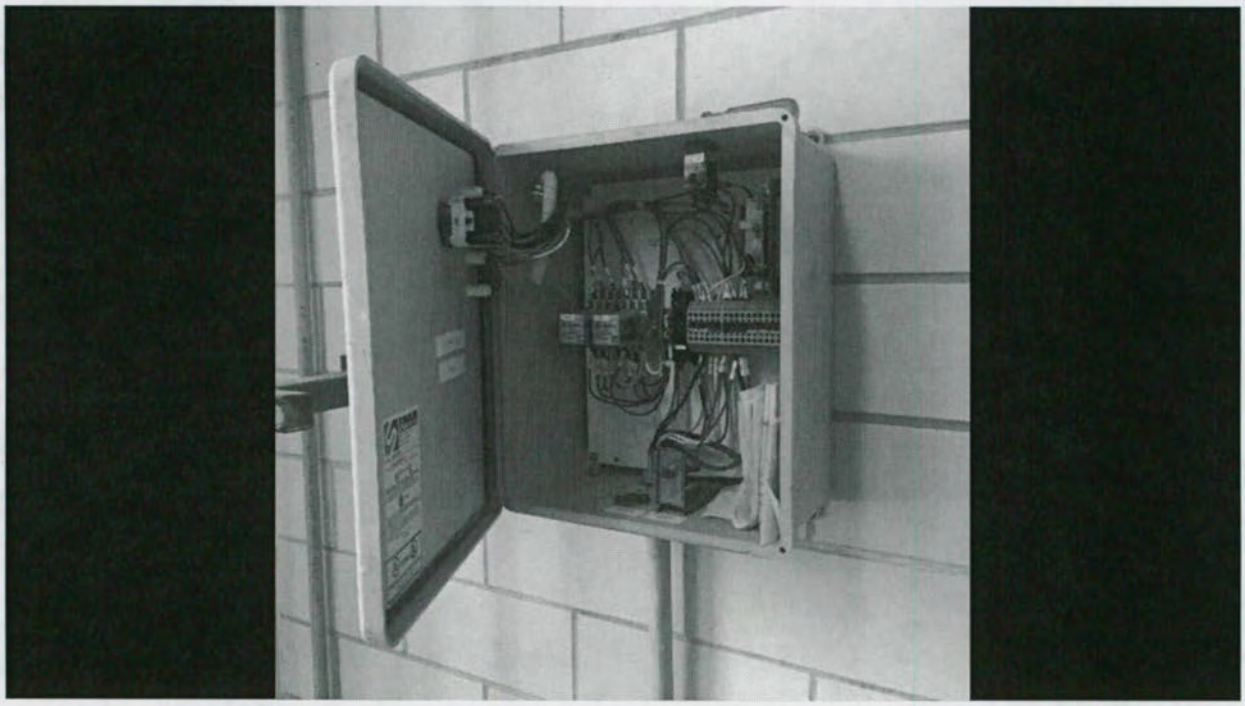




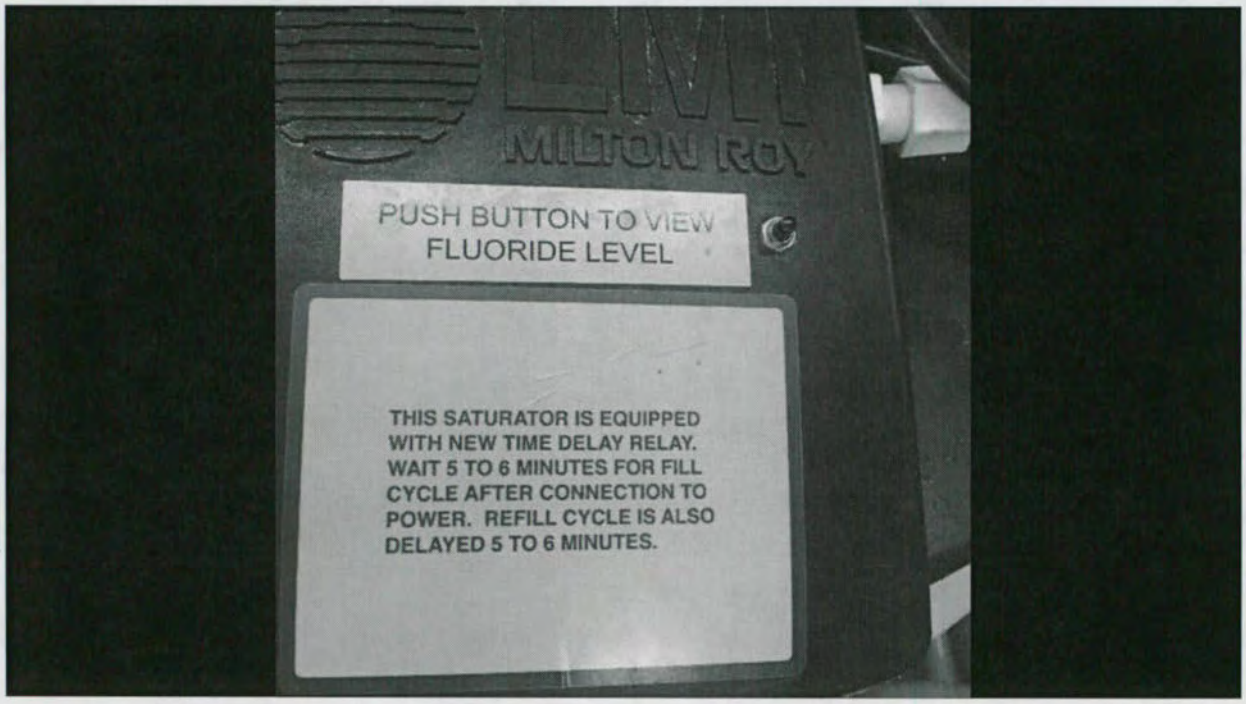


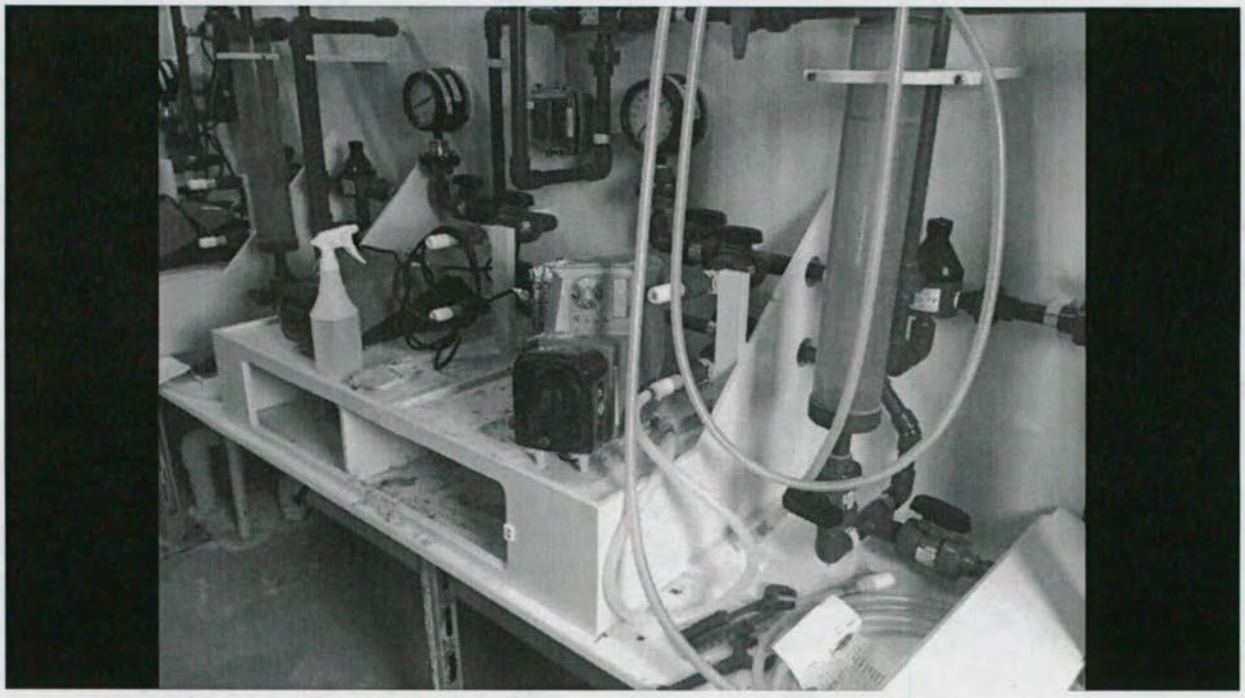


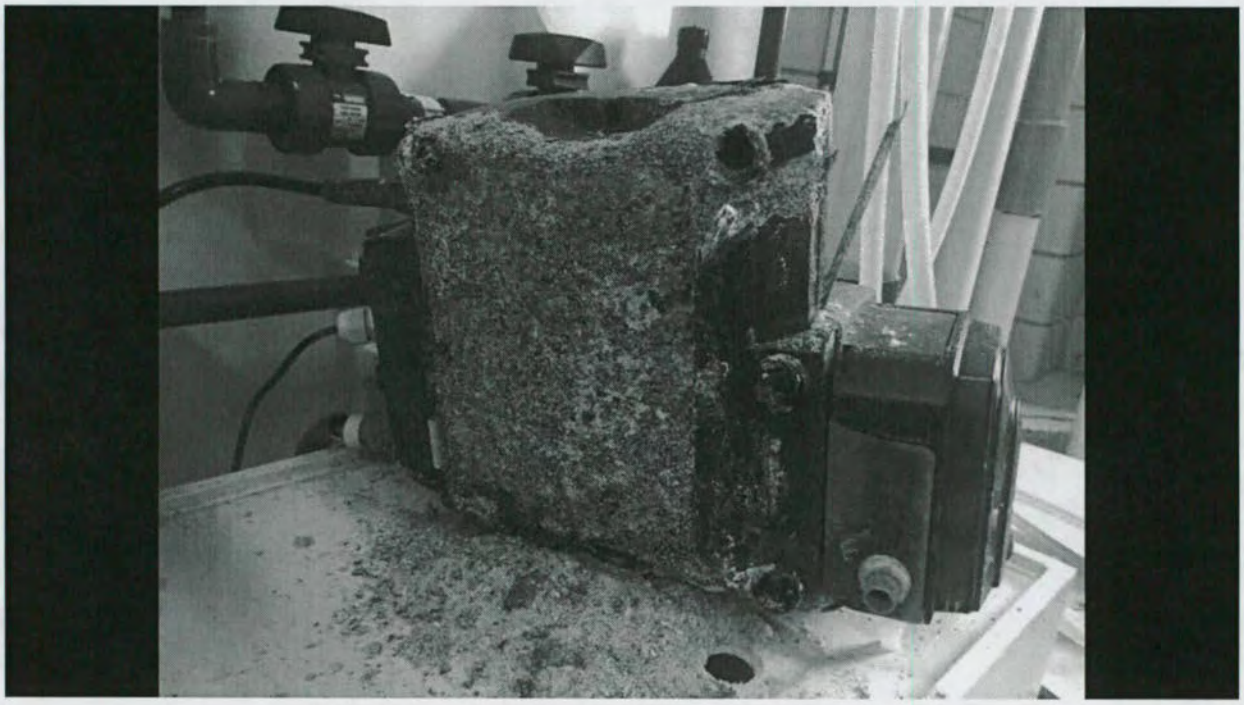


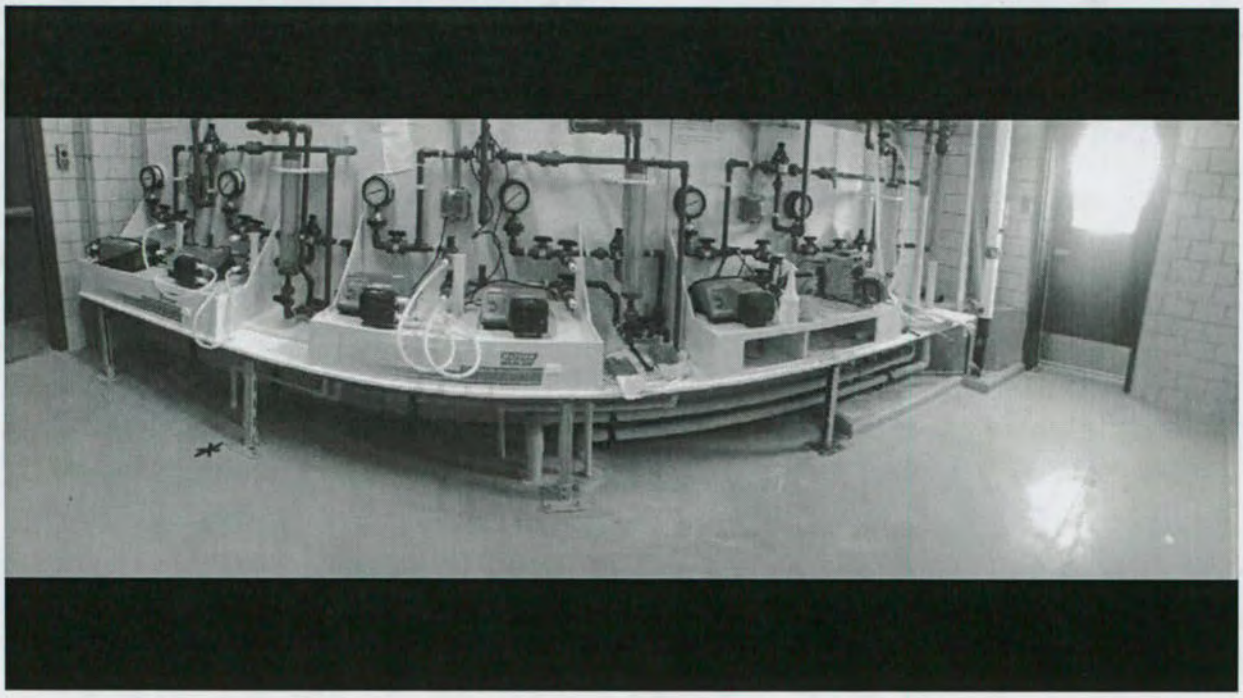


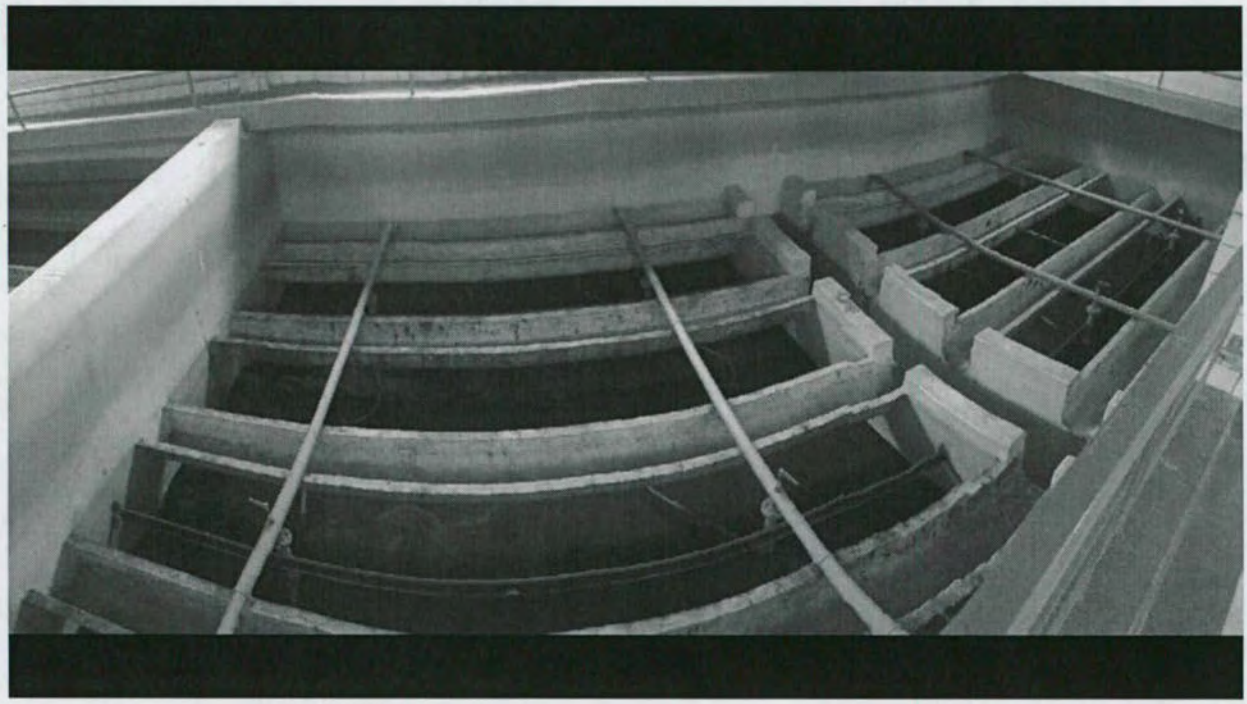

FLOURIDE ALARM PANEL

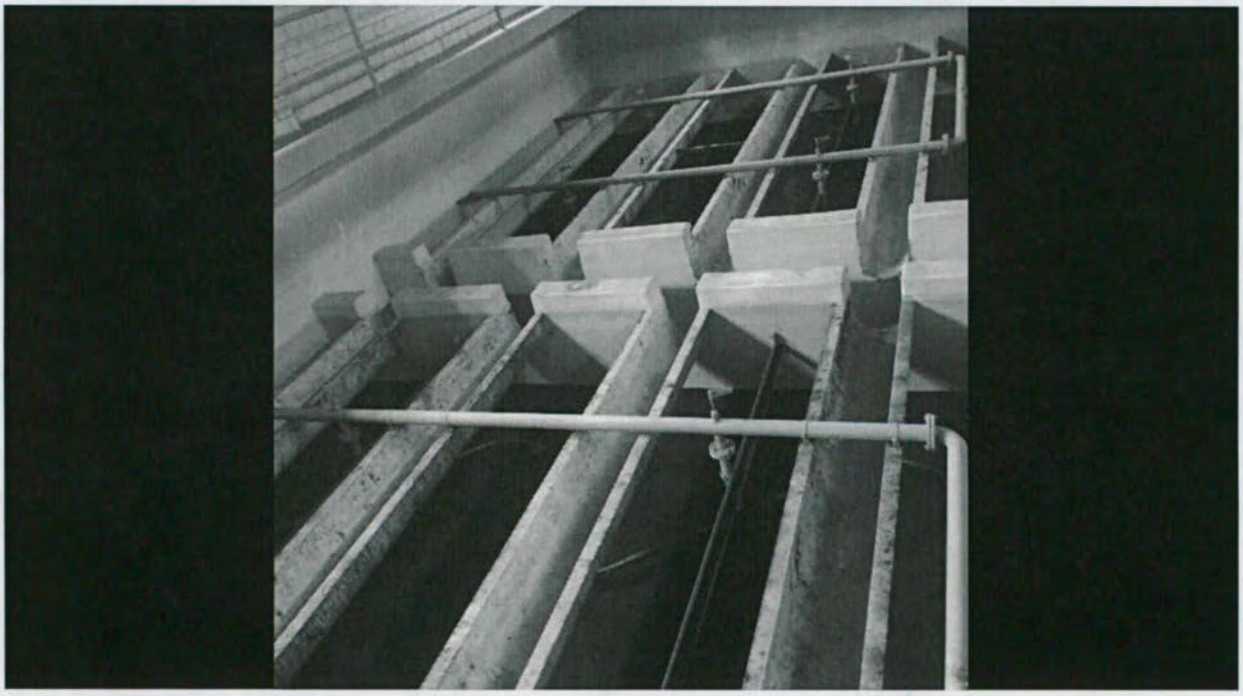

LMI
MILTON ROY
PUSH BUTTON TO VIEW
FLUORIDE LEVEL
THIS SATURATOR IS EQUIPPED
WITH NEW TIME DELAY RELAY.
WAIT 5 TO 6 MINUTES FOR FILL
CYCLE AFTER CONNECTION TO
POWER. REFILL CYCLE IS ALSO
DELAYED 5 TO 6 MINUTES.





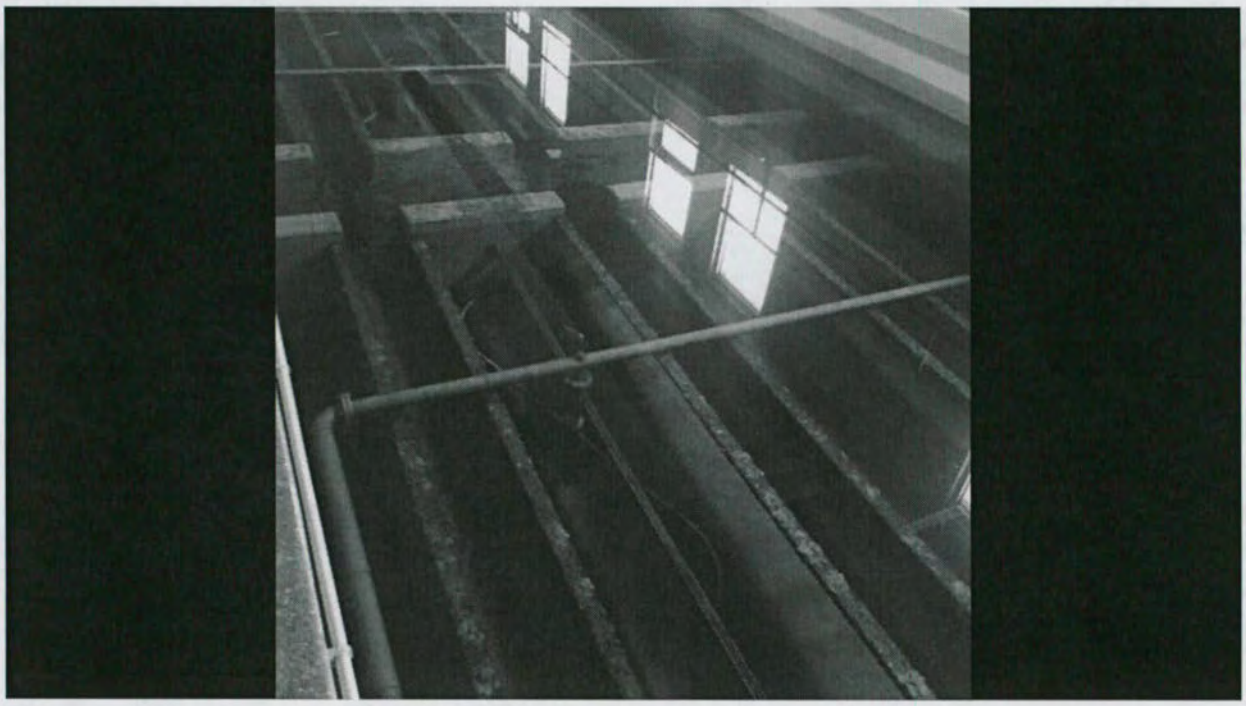










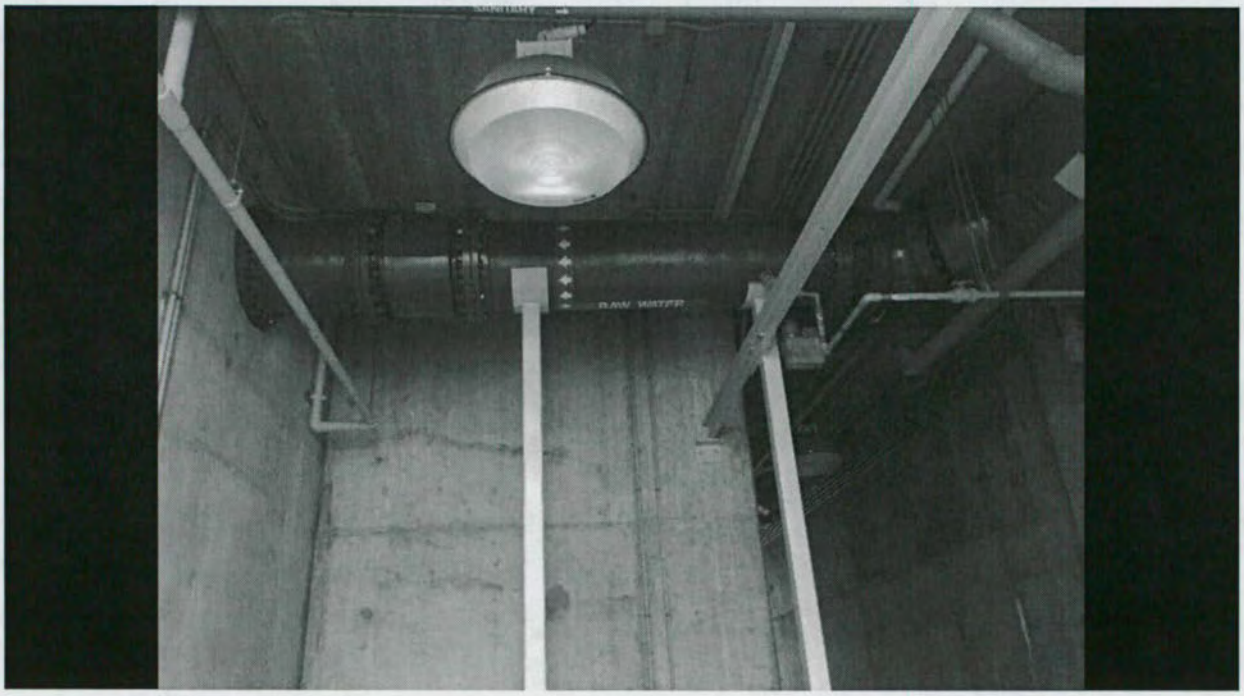


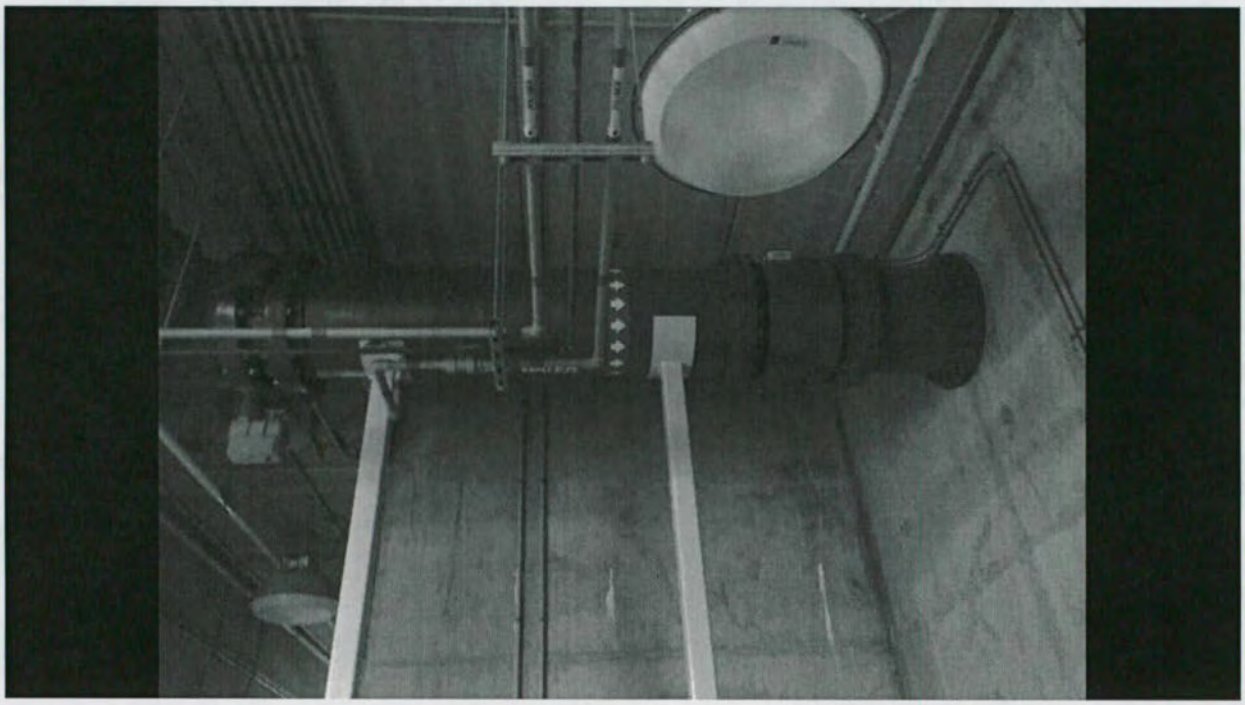

DO NOT
STAND
ON METAL
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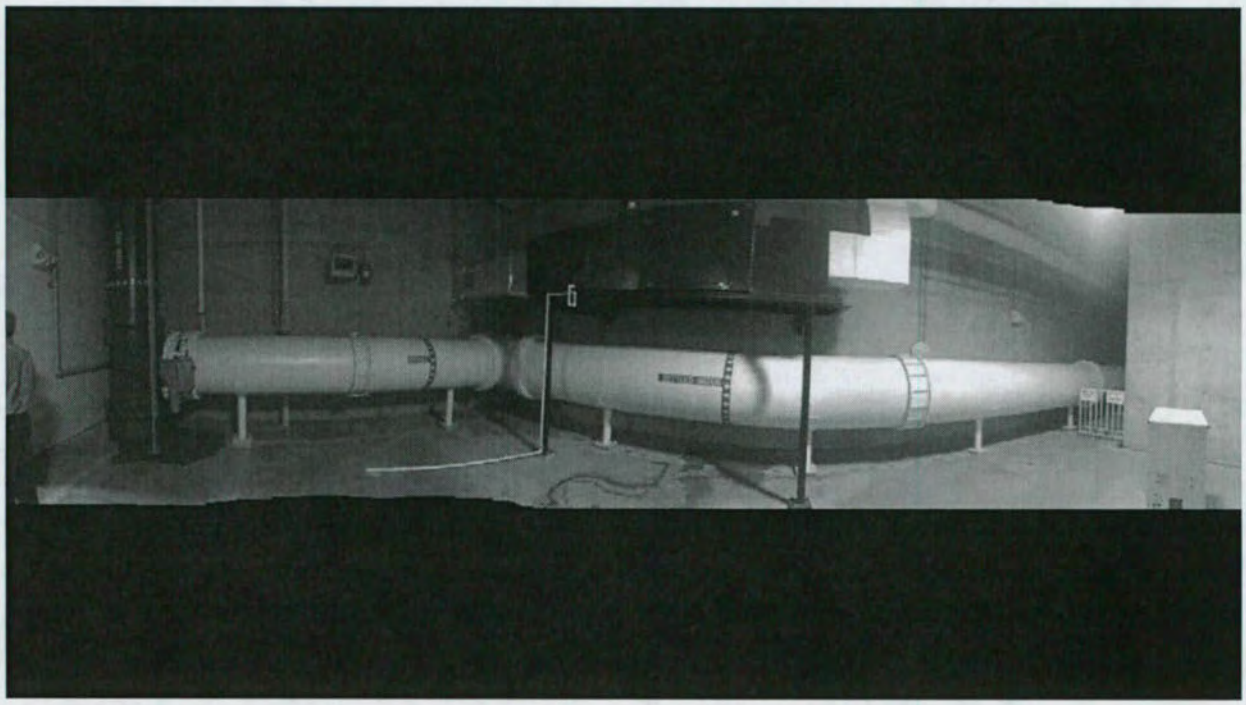




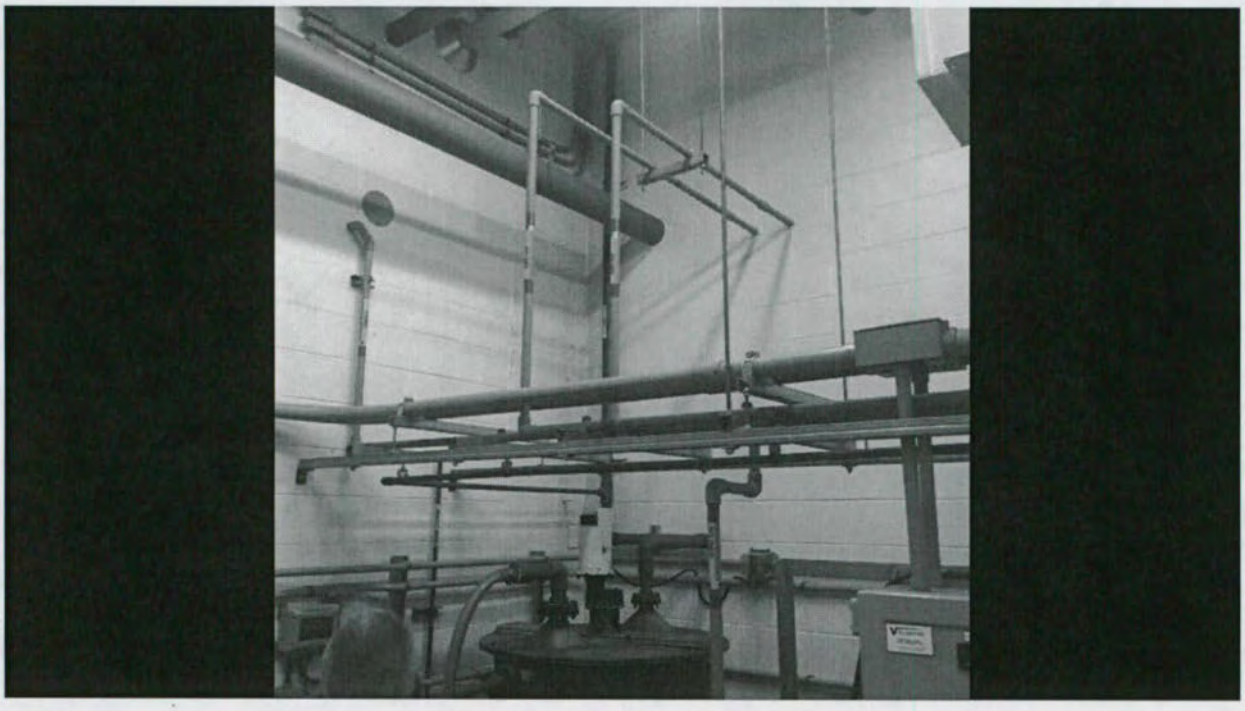





SIEMENS
SIEMENS













8/28/2018





8/28/2018







GRETCHEN WHITMER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY
GRAND RAPIDS DISTRICT OFFICE

LIESL EICHLER CLARK
DIRECTOR

November 1, 2019

Mr. Ellis Mitchell, City Manager
City of Benton Harbor
200 East Wall Street
Benton Harbor, Michigan 49022

WSSN: **00600**

Dear Mr. Mitchell:

SUBJECT: Administrative Consent Order: Progress Update and Revised Schedule

This letter is in response to discussions with Benton Harbor staff regarding the compliance schedule established in the Administrative Consent Order (ACO) effective March 5, 2019. Extensions for Section II - Compliance Schedule (Compliance Schedule) of the ACO were granted on April 1, 2019, May 16, 2019, and July 2, 2019. On October 17, 2019, the Department of Environment, Great Lakes, and Energy (EGLE) received another request for extensions of additional items in the Compliance Schedule. EGLE staff would like to acknowledge the competing timelines in the Compliance Schedule by granting the requested extension, and also reiterating the terms of the ACO.

Allowing sufficient time to complete tasks in the Compliance Schedule is necessary; however, timely implementation of items that will directly result in greater protection of public health must be prioritized. The table below includes an updated Compliance Schedule that satisfies the recent extension request from the City and sets interim deadlines for items requiring permitting.

Item	Initial Deadline	Extended Deadline	Status/Comment
Submit a rate study	4/1/2019	(completed)	
Submit plan to implement rate increases	4/1/2019	7/1/2020	Needs approval of Commission
Upgrade SCADA system for data access and storage	4/1/2019	(completed)	
Install flow meter on finished water	4/1/2019	12/15/2019	Needs further integration into SCADA
Install continuous chlorine analyzer on WTP tap	4/1/2019	(completed)	
Distribution Operator in charge	4/1/2019	(completed)	
Corrosion Treatment Study	4/1/2019	(completed)	
Submit updated rate collections plan	5/1/2019	12/31/2019	Coordinating with staff
Updated cross connection program including residential accounts	6/1/2019	3/31/2020	
Permit and Construct coagulant feed to existing rapid mix	6/1/2019	(completed)	
Submit maintenance plan for valves and hydrants	6/1/2019	06/30/2020	Allow time for staff to improve rate collections

Conduct professional inspection of water tower, or conduct cleaning and repaint interior	6/30/2019	12/31/2020	Delayed to allow for funding process
Install/repair mussel control system at intake	6/30/2019	4/1/2020	Submit permit application by 3/1/2020
Repair filter to waste valves	1/31/2020	9/1/2020	

Be advised that, per Paragraph 1.3 of the ACO, the City of Benton Harbor remains obligated to pay stipulated penalties of $500 per violation per day for failure to comply with a specific deadline set forth in the Compliance Program, including the extended deadlines set forth above.

It is our intention to work with you on resolving these issues in a timely manner. We anticipate and appreciate your cooperation in working together to resolve these matters. Additionally, if you have any questions regarding this Violation Notice, please contact me below or at sarkipatoe@michigan.gov.

Sincerely,

Ernie Sarkipato, Surface Water Treatment Specialist
Grand Rapids District Office
Drinking Water and Environmental Health Division
616-307-0261

cc/email: Mr. Mike O'Malley, Water Superintendent, Benton Harbor
Mr. Darold Harlan, Distribution Operator
Mr. Mike Bolf, P.E., Engineering Unit Supervisor, EGLE
Ms. Maureen Nelson, Enforcement Specialist, EGLE

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

RICK SNYDER
GOVERNOR

C. HEIDI GRETHER
DIRECTOR

March 8, 2019

CERTIFIED MAIL

The Honorable Marcus Muhammad
Mayor of Benton Harbor
200 East Wall Street
Benton Harbor, Michigan 49022

Dear Mayor Muhammad:

SUBJECT: Administrative Consent Order (ACO); City of Benton Harbor; WSSN: 00600

Enclosed please find a fully executed ACO between the City of Benton Harbor and the Department of Environmental Quality (DEQ), Drinking Water and Municipal Assistance Division (DWMAD), regarding the water supply at the City of Benton Harbor. The compliance schedule in this ACO is meant to bring the water supply into compliance with the Michigan Safe Drinking Water Act, 1976 PA 399, as amended. The effective date of the ACO is March 5, 2019.

If you have any questions regarding the ACO, please contact me at 616-490-9590; lachancea1@michigan.gov; or DEQ, P.O. Box 30817, Lansing, Michigan 48909-8311.

Sincerely,

Amy Lachance
Assistant Division Director
Drinking Water and Municipal Assistance Division

Enclosure
cc: Mr. Darwin Watson, City of Benton Harbor
Mr. Eric J. Oswald, DEQ
Mr. Brian Thurston, DEQ
Mr. Mike Bolf, DEQ
Mr. Ernie Sarkipato, DEQ
Mr. Dave Willard, DEQ

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER AND MUNICIPAL ASSISTANCE DIVISION

ADMINISTRATIVE CONSENT ORDER

In the matter of: DWMAD Order No. ACO-399-07-2019

SECTION I

FACILITY OWNER/OPERATOR

NAME	OWNER☒	OPERATOR☐
City of Benton Harbor		
DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS BUSINESS IDENTIFICATION NUMBER		
ADDRESS: 200 East Wall Street		
CITY: Benton Harbor	STATE: Michigan	ZIP CODE: 49022
CONTACT NAME/TITLE: Darwin Watson, City Manager	PHONE #: 269-927-8408	

FACILITY NAME AND LOCATION

FACILITY NAME: Benton Harbor Public Water Supply		WATER SUPPLY SERIAL NUMBER: 00600
FACILITY OWNER IF NOT IDENTIFIED ABOVE: City of Benton Harbor		
ADDRESS: 200 East Wall Street		
CITY: Benton Harbor	STATE: Michigan	ZIP CODE: 49022
COUNTY: Berrien		
CONTACT NAME: Darwin Watson	PHONE #: 269-927-8408	

1.1 This document results from allegations by the Department of Environmental Quality (DEQ), Drinking Water and Municipal Assistance Division (DWMAD). The DEQ alleges that the City of Benton Harbor, owner/operator of the city's public water supply, is in violation of the Safe Drinking Water Act, 1976 PA 399, as amended (Act 399), and the administrative rules promulgated thereunder.

1.2 Specific violations are referenced in the DEQ Significant Deficiency Violation Notice (SDVN) attached to this Administrative Consent Order (Consent Order) as Exhibit A. The Owner/Operator and the DEQ agree to resolve the violations set forth therein through entry of this Consent Order. The Owner/Operator agrees to resolve all compliance issues set forth in Exhibit A in accordance with the requirements contained in this Consent Order. This Consent Order, in its entirety, shall consist of Section I, the attached Sections II, III, and IV, Exhibit A, and any other referenced attachments, exhibits, or appendices. This Consent Order shall be considered null and void if it does not include, at a minimum, Sections I, II, III, and IV and Exhibit A. The Owner/Operator further agrees that this Consent Order shall become effective on the date it is signed by the DWMAD Director, designee of the DEQ Director.

1.3 The Owner/Operator agrees to pay a civil fine of $500 per day for failure to complete corrective actions as specified in Section II, Compliance Schedule, unless an extension has been approved under Section 4.14. Failure to make a timely payment constitutes a violation of this Consent Order.

1.4 The Owner/Operator agrees to make payment of all funds due pursuant to this agreement by certified check made payable to the "State of Michigan" and mailed to the Accounting Services Division, Cashier's Office for the DEQ, P.O. Box 30657, Lansing, Michigan 48909-8157. To ensure proper credit, all payments made pursuant to this Consent Order must include "Payment Identification Number RMD90044" on the check. The Owner/Operator agrees not to contest the legality of the civil fine.

Signatories

DEPARTMENT OF ENVIRONMENTAL QUALITY

Eric Oswald, Director
Drinking Water and Municipal Assistance Division

5-Mar-19
Date

I undersigned CERTIFY that I am fully authorized by the party identified above to enter into this Consent Order to comply by consent and to EXECUTE and LEGALLY BIND that party to it. I further attest that all information provided herein is accurate and true.

CITY OF BENTON HARBOR

Marcus Muhammad, Mayor

2/25/2019
Date

SECTION II - COMPLIANCE SCHEDULE

IT IS THEREFORE AGREED AND ORDERED THAT the Owner/Operator shall take the following actions to prevent further violations of Act 399 and the administrative rules promulgated thereunder and/or to correct the significant deficiencies identified in the SDVN attached to this Consent Order as Exhibit A.

2.1 Submit to the DWMAD a completed rate study from a qualified professional consultant, along with a plan to implement rate increases as recommended by the study, no later than April 1, 2019.

2.2 Upgrade the water plant supervisory and data acquisition (SCADA) system to allow for storage and easy access to required regulatory data including turbidity and chlorine, alarming for regulatory minimum levels, and potentially automation of some water plant operations, no later than April 1, 2019.

2.3 Install metering capabilities on the finished water no later than April 1, 2019.

2.4 Make necessary improvements to the water treatment facility in order to have a functioning and reliable continuous chlorine analyzer on the finished water tap no later than April 1, 2019.

2.5 Obtain an adequately licensed operator in charge, solely dedicated to the water distribution system, no later than April 1, 2019.

2.6 Submit a proposal for optimal corrosion control treatment or a corrosion control study to the DWMAD no later than April 31, 2019.

2.7 Submit to the DWMAD an implementation plan for a consistent and equitable rate collection program to minimize the number of unpaid bills and streamline the collections process, no later than May 1, 2019.

2.8 Submit an updated cross connection program for DWMAD approval, incorporating the City's plan for implementing control of residential accounts, and for obtaining adequate personnel to implement the City's cross connection control program, no later than June 1, 2019.

2.9 Install necessary modifications at the water treatment plant to inject coagulant chemical at a DWMAD-approved rapid mix location, and develop a standard operating procedure for feeding coagulant, no later than June 1, 2019.

2.10 Submit a plan to the DWMAD for inventorying and ongoing maintenance of distribution valves and hydrants, no later than June 1, 2019.

2.11 Conduct professional inspection of the elevated tank interior and exterior no later than June 30, 2019.

2.12 Install working mussel control system at the intake no later than June 30, 2019.

2.13 Repair filter to waste valves no later than January 1, 2020.

Sections III and IV of this Consent Order shall not be altered in any way, including adding or eliminating any language, striking terms or parts of terms, retyping in whole or in part, or using a different format. Any changes to this document without written approval from the DEQ renders the Consent Order null and void.

SECTION III - STIPULATIONS

The Owner/Operator and the DEQ stipulate as follows:

3.1 The DEQ is authorized to enter this Consent Order requiring the Owner/Operator to comply with state law under Section 15 of Act 399.

3.2 The Owner/Operator consents to the issuance and entry of this Consent Order and stipulates that the entry of this Consent Order constitutes a final order of the DEQ and is enforceable as such under the appropriate provisions of state law identified in this Consent Order. The Owner/Operator agrees not to contest the issuance of this Consent Order and that the resolution of this matter by the entry of this Consent Order is appropriate and acceptable.

3.3 The Owner/Operator and the DEQ agree that the signing of this Consent Order is for settlement purposes only and does not constitute an admission by the Owner/Operator that the law has been violated.

3.4 The Signatory to this Consent Order on behalf of the Owner/Operator agrees and attests that he/she is fully authorized to ensure that the Owner/Operator will comply with all requirements under this Consent Order.

3.5 The Owner/Operator shall achieve compliance with the aforementioned regulations in accordance with the requirements contained in Section II of this Consent Order.

SECTION IV - GENERAL PROVISIONS

The Owner/Operator and the DEQ further stipulate as follows:

4.1 With respect to any violations not specifically addressed and resolved by this Consent Order, the DEQ reserves the right to pursue any other remedies to which it is entitled for any failure on the part of the Owner/Operator to comply with the requirements of Act 399 and the administrative rules promulgated thereunder.

4.2 The DEQ and the Owner/Operator consent to enforcement of this Consent Order in the same manner and by the same procedures for all final orders entered pursuant to the provisions of Act 399.

4.3 This Consent Order in no way affects the Owner/Operator's responsibility to comply with any other applicable local, state, or federal laws or regulations.

4.4 The DEQ reserves its right to pursue appropriate action, including injunctive relief to enforce the provisions of this Consent Order, and applicable statutory fines for any violation of this Consent Order.

4.5 Nothing in this Consent Order is or shall be considered to affect any liability the Owner/Operator may have for natural resource damages caused by the

Owner/Operator's acts or omissions at the facility. The State of Michigan does not waive any rights to bring an appropriate action to recover such damages to the natural resources.

4.6 In the event the Owner/Operator sells or transfers the facility, he/she shall advise any purchaser or transferee of the existence of this Consent Order in connection with such sale or transfer. Within 30 calendar days, the Owner/Operator shall also notify the DWMAD Engineering Unit, in writing, of such sale or transfer, the identity and address of any purchaser or transferee, and confirm the fact that notice of this Consent Order has been given to the purchaser and/or transferee. The purchaser and/or transferee of this Consent Order must agree, in writing, to assume all of the obligations of this Consent Order. A copy of that agreement shall be submitted to the DWMAD Engineering Unit within 30 days of assuming the obligations of this Consent Order.

4.7 The provisions of this Consent Order shall apply to and be binding upon the parties to this action and their successors and assigns.

4.8 This Consent Order constitutes a civil settlement and satisfaction as to the resolution of the violations specifically addressed herein; however, it does not resolve any criminal action that may result from these same violations.

Reporting

4.9 The Owner/Operator shall make all submittals and written notifications required by this Consent Order, to the DWMAD Engineering Unit, DEQ, Grand Rapids District Office, 350 Ottawa Avenue NW, Unit 10, Grand Rapids, Michigan 49503. The cover letter with each submittal or notification shall identify the specific paragraph and requirement of this Consent Order that the submittal or notification is intended to satisfy.

4.10 The Owner/Operator shall verbally report any violation(s) of the terms and conditions of this Consent Order to the DWMAD Engineering Unit Supervisor at 231-590-3430 by no later than the close of the next business day following detection of such violation(s) and shall follow such notification with submittal of a written report within five business days following detection of such violation(s). The written report shall include a detailed description of the violation(s), as well as a description of any actions proposed or taken to correct the violation(s). The Owner/Operator shall report any anticipated violation(s) of this Consent Order to the above-referenced individual in advance of the relevant deadlines whenever possible.

Retention of Records

4.11 Upon request by an authorized representative of the DEQ, the Owner/Operator shall make available to the DEQ all records, plans, logs, and other documents required to be maintained under this Consent Order or pursuant to applicable laws or rules. All such documents shall be retained by the Owner/Operator for at least a period of three years from the date of generation of the record unless a longer period of record retention is required by the applicable law or its rules.

Right of Entry

4.12 The Owner/Operator shall allow any authorized representative or contractor of the DEQ, upon presentation of proper credentials, to enter upon the premises of the facility at all

reasonable times for the purpose of monitoring compliance with the provisions of this Consent Order. This paragraph in no way limits the authority of the DEQ to conduct tests and inspections pursuant to Act 399 and the administrative rules promulgated thereunder or any other applicable statutory provision.

DEQ Approval of Submittals

4.13 For any work plan, proposal, or other document, excluding applications for permits or licenses, that are required by this Consent Order to be submitted to the DEQ by the Owner/Operator, the following process and terms of approval shall apply:

a. All work plans, proposals, and other documents required to be submitted by this Consent Order shall include all of the information required by the applicable statute and/or rule and all of the information required by the applicable paragraph(s) of this Consent Order.

b. In the event the DEQ disapproves a work plan, proposal, or other document, it will notify the Owner/Operator, in writing, specifying the reasons for such disapproval. The Owner/Operator shall submit, within 30 days of receipt of such disapproval, a revised work plan, proposal, or other document that adequately addresses the reasons for the DEQ's disapproval. If the revised work plan, proposal, or other document is still not acceptable to the DEQ, the DEQ will notify the Owner/Operator, in writing, of this disapproval.

c. In the event the DEQ approves with specific modifications, a work plan, proposal, or other document, it will notify the Owner/Operator, in writing, specifying the modifications required to be made to such work plan, proposal, or other document prior to its implementation and the specific reasons for such modifications. The DEQ may require the Owner/Operator to submit, prior to implementation and within 30 days of receipt of such approval with specific modifications, a revised work plan, proposal, or other document that adequately addresses such modifications. If the revised work plan, proposal, or other document is still not acceptable to the DEQ, the DEQ will notify the Owner/Operator, in writing, of this disapproval.

d. Upon DEQ approval, or approval with modifications, of a work plan, proposal, or other document, such work plan, proposal, or other document shall be incorporated by reference into this Consent Order and shall be enforceable in accordance with the provisions of this Consent Order.

e. Failure by the Owner/Operator to submit an approvable work plan, proposal, or other document, within the applicable time periods specified above, constitutes a violation of this Consent Order and shall subject the Owner/Operator to the enforcement provisions of this Consent Order.

f. Any delays caused by the Owner/Operator's failure to submit an approvable work plan, proposal, or other document when due shall in no way affect or alter the Owner/Operator's responsibility to comply with any other deadline(s) specified in this Consent Order.

g. No informal advice, guidance, suggestions, or comments by the DEQ regarding reports, work plans, plans, specifications, schedules, or any other writing submitted

by the Owner/Operator will be construed as relieving the Owner/Operator of his/her obligation to obtain written approval, if and when required by this Consent Order.

Extensions

4.14 The Owner/Operator and the DEQ agree that the DEQ may grant the Owner/Operator a reasonable extension of the specified deadlines set forth in this Consent Order. Any extension shall be preceded by a written request to the DWMAD Engineering Unit no later than ten business days prior to the pertinent deadline and shall include:

a. Identification of the specific deadline(s) of this Consent Order that will not be met.

b. A detailed description of the circumstances that will prevent the Owner/Operator from meeting the deadline(s).

c. A description of the measures the Owner/Operator has taken and/or intends to take to meet the required deadline(s).

d. The length of the extension requested and the specific date on which the obligation will be met.

No change or modification to this Consent Order shall be valid unless in writing from the DEQ and, if applicable, signed by both parties.

Termination

4.15 This Consent Order shall remain in full force and effect until terminated by a written Termination Notice (TN) issued by the DEQ. Prior to issuance of a written TN, the Owner/Operator shall submit a request consisting of a written certification that the Owner/Operator has fully complied with the requirements of this Consent Order and has made payment of any fines required in this Consent Order. Specifically, this certification shall include:

a. The date of compliance with each provision of the compliance program in Section II of this Consent Order, and the date any fines or penalties were paid.

b. A statement that all required information has been reported to the DWMAD Engineering Unit.

c. Confirmation that all records required to be maintained pursuant to this Consent Order are being maintained at the facility.

The DEQ may also request additional relevant information. The DEQ shall not unreasonably withhold issuance of a TN.

Exhibit A
Administrative Consent Order

Enforcement Type	Issue Date
Significant Deficiency Violation Notice	October 3, 2018

RICK SNYDER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
GRAND RAPIDS DISTRICT OFFICE

C. HEIDI GRETHER
DIRECTOR

October 3, 2018

CERTIFIED MAIL

Mr. Marcus Muhammad, Mayor
Mr. Darwin Watson, City Manager
City of Benton Harbor
200 Wall Street
Benton Harbor, MI 49022

SIGNIFICANT DEFICIENCY VIOLATION NOTICE
WSSN: **00600**

Dear Sirs:

SUBJECT: City of Benton Harbor (City) - Water System Sanitary Survey and Significant Deficiency Violation Notice – Financial and Managerial Capacity

This letter will confirm meetings with Benton Harbor staff on multiple dates in 2017 and 2018; representing the Department of Environmental Quality (DEQ), Drinking Water and Municipal Assistance Division (DWMAD), and summarize the subsequent review and discussion of the water supply facilities serving the City of Benton Harbor (City). The purpose of these meetings and subsequent review is to evaluate the water system with respect to the requirements of the Michigan Safe Drinking Water Act, 1976 PA 399, as amended (Act 399). **Findings from the survey, listed below, have led to the determination the water supply currently lacks the financial and managerial capacity to meet all the requirements of Act 399.** Findings of significant deficiency have been identified as having the potential to introduce contamination to the public water supply and must be addressed within 120 days or be outlined in a corrective action plan and schedule approved by this office.

Since the previous sanitary survey in 2015, staff at the City of Benton Harbor have made significant efforts to maintain and improve the historically neglected water system. The distribution pipe network alone represents $124 million in replacement value, according to the 2017 asset management program by Abonmarche. Along with the City's complex treatment plant, this represents a significant challenge for the City in terms of maintenance costs. Proper care and maintenance of the system is necessary to protect the health of all customers.

The major findings below indicate a number of areas needing immediate attention by the City, many of which have the potential to impact public health by allowing or introducing contamination to the water supply. Of utmost importance, a review of financial information finds the City presently lacks an adequate financial mechanism to conduct necessary improvements or hire necessary staff to properly maintain and operate the water system. **We strongly advise the City to work with a qualified financial consultant to identify the revenue necessary to support operation and maintenance and to implement effective revenue collection methodologies.** Investment from the City's rate payers is essential for resolving the below (significant) deficiencies and for ensuring the long term vitality of the water system assets.

The following table summarizes our findings from our survey of the water system:

Survey Element	Findings
Source	**Deficiencies Identified**
Treatment	**Significant Deficiencies Identified**
Distribution System	**Significant Deficiencies Identified**
Finished Water Storage	**Deficiencies Identified**
Pumps	Recommendations made
Monitoring & Reporting	**Significant Deficiencies Identified**
Management & Operations	**Significant Deficiencies Identified**
Operator Compliance	Recommendations made
Security	No Deficiencies or Recommendations
Financial	**Significant Deficiencies Identified**
Other	**Significant Deficiencies Identified**

The following significant deficiencies are violations of Act 399 with the potential to allow or introduce contamination to the public water supply, and must either be resolved within 120 days or be included in an approved corrective action plan.

D1. Our review included the City's asset management program, submitted in December 2017, as well as the bill payment and collections process. Current revenues are not sufficient to cover capital improvement costs, and necessary improvements identified in this survey are likely to increase operations and maintenance costs beyond the current revenues. In addition, the current water bill collection process is inadequate and creates a significant drain on staff resources and time, which would be better spent towards resolution of significant deficiencies and performance of routine maintenance activities. **In order to maintain the required financial capacity to operate a public water supply, the City must:**

a. Conduct a rate study with a qualified professional consultant, and implement findings to generate sufficient revenue to cover costs.
b. Implement a consistent and equitable program to minimize the number of unpaid bills, and streamline the collections process.

D2. An increasing trend in the number of violations of Act 399 in the past year indicates the need for increased managerial oversight of the water supply. In addition, maintenance of the water plant and distribution system components is severely lacking. The lack of separate designated distribution and plant managers prevents staff from spending adequate time and energy on managing the water system. **In order to maintain the managerial capacity to operate the public water supply and meet the requirements of Act 399, the City must hire separate certified operators to oversee the distribution system and the water treatment facility.**

D3. R 325.11008 (2) requires a sufficient primary coagulant dose shall be added to create a settleable or filterable floc at all times. Currently the City adds coagulant to an injection point in the raw water influent pipe rather than the engineered rapid mix basins in the new plate settler building. It has become apparent, through a near violation of turbidity standards in February of 2018, as well as an ongoing treatment technique violation of R 325.10610c, this coagulation practice is not acceptable to meet the requirements of Act 399. Lack of proper mixing also impacts the pathogen removal credit awarded to properly operated conventional treatment facilities. **Adequate rapid mix for the primary coagulant must be installed.**

The current raw water pH of Lake Michigan is above the optimum operating range of the City's current coagulant, aluminum sulfate. At these elevated pH ranges, iron based coagulants, such as ferric sulfate or ferrous sulfate may be more suited for creating a settleable or filterable floc. The City should hire a consultant to explore the steps necessary to explore a switch of the primary coagulant.

D4. R 325.10720 (3) requires continuous monitoring for residual disinfectant at an entry point to the distribution system (EPTD) on a continual basis, and requires the minimum to be recorded for each day. The chlorine analyzer at the City's EPTD was reading less than 0.2 mg/L, the minimum required residual under R325.10611a(2)(b). The readings were identified as unreliable by the operator, and are not recorded as required above. Moreover, plant staff were not familiar with the operational setpoints necessary to achieve sufficient disinfection. **Accurate chlorine analyzer must be in place, minimum levels recorded daily and reported to the DEQ, and connected to SCADA with callout alarms in the event of low residual.**

D5. R 325.11404 requires a water supply to develop a comprehensive control program for the elimination and prevention of all cross connections. The program must include education, inspection, preventer testing in all customer sectors including residential. In addition, an annual report summarizing activities must be submitted to the DEQ. The City has insufficient staff to conduct any activities for the last few years, as evidenced by the lack of annual reporting. **The City must dedicate a trained staff person to implement this program or obtain a contract with a qualified professional company to implement the program.**

D6. R325.11108 requires a water supply to have sufficient valves in the distribution system to minimize interruptions in service and minimize sanitary hazards during construction or repairs. In addition, R 325.11111 requires adequate records be maintained on the distribution system components including hydrants and valves. The City has struggled to conduct necessary inventory and maintenance on valves in the system. **A plan for valve inventory and maintenance must be submitted, approved and implemented consistently.**

D7. R 325.11105 requires a water supply distribution system to maintain a minimum pressure of 20psi throughout the system during emergencies such as firefighting, and allows the department to prohibit installation of fire hydrants in areas where fire flow is not sufficient. From our discussion with staff and through the hydrant flow testing activities conducted during the reliability study, a number of hydrants in town have no flow or zero flow. This may be related to closed valves in the system, which significantly impacts public safety should an emergency occur. **A plan for hydrant inventory and maintenance must be submitted,**

approved and implemented consistently.

D8. The water plant's supervisory control and data acquisition (SCADA) system is in need of upgrades to achieve the following requirements:

a. Storage and access to regulatory data such as EPTD chlorine residuals (R 325.10720), plant flow, and individual filter turbidity profiles (R10720a).
b. Alarming capabilities to call out during unstaffed hours for low chlorine residual, low tower level, high turbidity at the filter confluence point and other undesirable conditions.
c. Automation of water plant operations may be enhanced to allow staff to focus on maintenance activities.

The following deficiencies are also violations of Act 399, and must be resolved to return to compliance with Act 399.

D9. Install finished water meters at the water plant to facilitate accurate calculations and reporting of chemical treatment, calculation of non-revenue water, and more accurate calculation of CT.

D10. Significant amounts of unlined cast iron water main are in need of replacement. With funding in place, the City must prioritize replacement of old water main that is unreliable and undersized.

D11. The monthly operating report must accurately reflect the data collected at the water plant. For example, treated water has been estimated using raw water meters, and chlorine at the plant tap should be the minimum recorded for the day from the EPTD continuous analyzer as opposed to bench top analysis.

D12. Conduct a professional inspection on the elevated tank, including necessary maintenance and cleaning. This may be facilitated by installing variable frequency drive(s) on high service pumps, which would allow operating on pressure rather than on tower level.

If you have any information you would like us to consider regarding the significant deficiencies identified in this Significant Deficiency Violation Notice, please provide it in a written response by November 2, 2018.

Representatives from the City and DEQ met on September 14, 2018 to discuss preliminary findings of the sanitary survey, and to begin discussion of a corrective action plan such as an administrative consent order (ACO), to return to compliance. It is understood that a significant amount of time will be required to address many of these issues. Therefore, we recognize that this ACO contains a schedule, which is both systematic and flexible, to bring the City back into compliance with the SDWA and providing a safe and reliable source of drinking water to its residents. Upon hearing from the City of its desire to move forward with an ACO, we will forward a draft ACO for the City's review and comment. At that time, DEQ staff will be available to meet with City officials to discuss the ACO in an attempt to execute it prior to the 120 day deadline.

A reliable supply of quality drinking water is critical to the growth and strength of any community. We are committed to working with the City to improve the water distribution system and treatment plant. With a strong commitment and swift effort from the City, we believe these deficiencies can be resolved and lead to long term water system sustainability.

We anticipate and appreciate your cooperation in resolving this matter. If you have any questions regarding this Significant Deficiency Violation Notice, please contact me by telephone at 616-307-0261; by e-mail at sarkipatoe@michigan.gov; or DEQ-DWMAD, 350 Ottawa Avenue NW, Unit 10, Grand Rapids, Michigan 49506.

Sincerely,

Ernie Sarkipato, P.E.,
Surface Water Treatment Specialist
Drinking Water and Municipal Assistance Division

Enclosure

cc: Berrien County Health Department
cc/enc: Mr. Mike O'Malley, Operator in Charge, City of Benton Harbor
Mr. Eric Oswald, Director, DEQ (via email)
Ms. Sue Maul, Enforcement Specialist, DEQ (via email)
Mr. Jon Bloemker, Engineering Unit Supervisor, DEQ (via email)

7953 Adobe Road
Kalamazoo, Michigan
Phone: 269-567-3500
Fax: 269-567-9440

WSSN: 0600

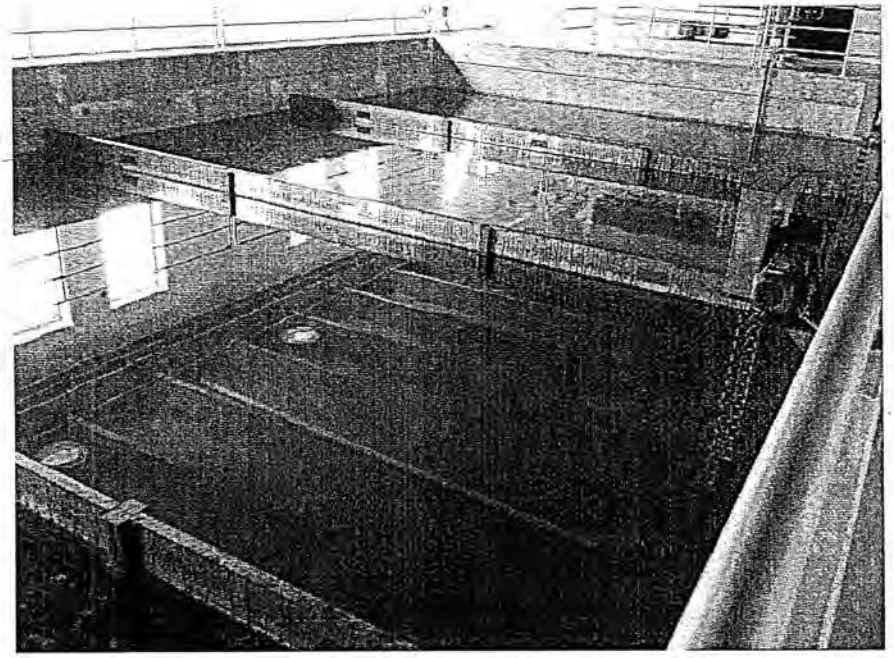
Office of Drinking Water and Municipal Assistance

Kalamazoo District Office

2015

Water System Sanitary Survey

City of Benton Harbor



DEQ

Sanitary Survey of Community Water Supply - Review Summary

Water Supply: City of Benton Harbor
County: Berrien
Evaluator: Wozniak

WSSN: 00600
District: 52
Dates: 6/16/2015

Category	Comment	N/A	NotEv	NoD/R	Rec	Def	SigDef
Source							
Construction & Maintenance	*Have comprehensive inspection performed*				X		
Standby Power				X			
Isolation				X			
Source Water Protection				X			
Capacity	*Inspect intake / clean if necessary*				X		
Treatment							
Disinfection				X			
Fluoride	*evaluate consistancy of application, repair as necessary*				X		
Phosphate Addition		X					
Softening		X					
Iron/Manganese Removal		X					
Arsenic Removal		X					
Pretreatment	*evaluate G value on mixers and floc tanks*				X		
Filtration (gravity or membranes)	*repair spray wash*				X		
C*T							
Other							
Distribution System							
Interconnections w/ Other WS	*interconnection agreement with BCT*				X		
Hydrants & Valves	*inventory, replace non-working valves, and maintain*					X	
Service Lines & Metering				X			
General Plan	*update by 1/1/2016*				X		
Cross Connections	*perform high hazard inspections*					X	
Construction & Maintenance				X			
Capacity	*Reduce unnaccounted for water amounts*				X		
Finished Water Storage							
Construction & Maintenance				X			
Controls				X			
Capacity				X			
Pumps (All Pumping Facilities)							
Construction & Maintenance	*evaluate/repair treatment pumps*				X		
Controls				X			
Capacity				X			
Monitoring & Reporting							
Bacteriological Monitoring				X			
Chemical Monitoring				X			
MOR or Annual Pumpage Report				X			
Consumer Confidence Report				X			
Analytical Capabilities				X			
System Management & Operations							
Owner Responsibility				X			
Capacity Development				X			
Reliability Study	*update by 1/1/2016*				X		
Operations Oversight	*Hire distribution foreman*				X		
Permits				X			
Operator Compliance							
Operator Certification	*obtain F1 back up operator*				X		
Technical Knowledge & Training				X			
Security							
Emergency Response Plan	*update ERP as necessary*				X		
Site Security (Fences, Alarms...)				X			
Financial							
Rates				X			
Budget & Capital Imp. Plan	*Update CIP by 1/1/2016*				X		
Other							

N/A - Not Applicable
Rec - Recommendations Made
NotEv - Not Evaluated
Def - Deficiencies Identified
NoD/R - No Deficiencies/Recommendations Made
SigDef - Significant Deficiencies Identified

Sanitary Survey
Evaluation Form

Basic Data

Name of Supply: City of Benton Harbor

WSSN: 00600

Review Dates: February 26, 2015, April 16, 2015, June 16, 2015

Reviewed By: Gary Wozniak, P.E.

Mailing Address:

City of Benton Harbor
200 East Wall Street
Benton Harbor, MI 49022
Phone: (269) 927-8400
Fax: (269) 927-0304

Plant Address

Benton Harbor WTP
601 North Ridgeway Drive
St. Joseph, MI 49085
Phone: (269) 927-8471
Fax: (269) 927-8469

City Officials:

Mayor: James Hightower
City Manager: Darwin Watson, dwatson@cityofbentonharbormi.gov, (269) 927-8400
Utilities Director: Stewart Beach, sbeach@cityofbentonharbormi.gov, (269) 363-0575 cell
Operator-In-Charge: Stewart Beach
Designated Backup Operator: Denny Edwards
Distribution System Superintendent: Stewart Beach

Water Treatment Plant Operators:

	Name	Licenses	Operator ID
1.	Stewart Beach	F-1, S-1	2273
2.	Denny Edwards	F-4, S-4	4753
3.	Doug Vanderploeg	F-3, S-3	2171
4.	Joe Archibald	F-4	17378
5.	Darwin Watson	S-2, F-4 (exp.)	4710

Retail Customers:	Name	Population
1	City of Benton Harbor	10,038 (2010 census)

Wholesale Customers: None

SANITARY SURVEY EVALUATION FORM

Total Population Served: 10,038
Percent Metered: City – 100 percent

Percent Unaccounted: ~ 40 percent

Water System Construction Features & Dates:

1. Water system construction prior to 1914. Old state records indicate well and pumping station at this time.
2. 1927 Water Filter Plant in service
3. 1930 Additional Kelly well installed.
4. 1937 Water softening plant additions.
5. 1949/50 Construction of 12 MGD rapid sand filter plant including 2 upflow pretreatment units. Design by Consoer, Townsend & Associates.
6. 1951 Fluoridation equipment installed.
7. 1954 Remaining four of twelve filters equipped.
8. 1967 Construction of Grand Blvd. and M-139 booster stations and ground reservoir.
9. 1968 Construction of Euclid Ave. standpipe and booster station.
10. 1989/90 Installation of 6 MGD low service pump, chlorination, and chemical feed upgrades, replacement of switch gear, replaced filter valves and controls, plant metering and instrumentation, and customer meters.
11. 1991 New media and underdrains in six of the twelve filters.
12. 1995 Repair of one filter underdrain (#4) and new media and underdrains in two additional filters (#3, #7)
13. 1997 Installation of chlorine connection in new spool piece on raw water intake; new traveling screens.
14. 1997 Security improvements; fencing around plant, exterior lighting on clarifiers and chemical storage building.
15. 1997 New underdrain and media in filter #8.
16. 1998 Warranty work on filters #1, #2, #5, and #6 (new underdrains)
17. 2002 New media in filters #5 and #6.
18. 2005, Replaced all filter influent and effluent valves.
19. 2010 Large-scale DWRF project to include water plant and distribution improvements. Includes new plate settling basins with inclined plate settlers, filter-to-waste provisions for all filters, rehabilitation of filters 9-12, a backwash lagoon, and conversion from gas chlorine to liquid chlorine.
20. 2011 Benton Charter Township constructs transmission main to separate the Township distribution system from the City.

21. 2013 St. Joseph Charter Township constructs transmission mains to separate the Fairplain neighborhood (St Joseph Twp.) from the City water system.

Is Vulnerability Assessment Available For Review? Yes

Is Emergency Response Plan Available For Review? Yes

Plant Personnel/Construction/Security Comments: The City of Benton Harbor (City) is classified as an F-1 conventional treatment water plant, and must be attended by an F-licensed shift operator when the water plant is in operation. Plant operation is defined when the plant is treating water to protect public health and operation occurs whenever the low service pumps are running. Currently only Mr. Beach has an F-1 license. The City is encouraged (not required) to have at least one other operator with an F-1 license. The City meets the certified operation and oversight requirements in water treatment. The existing staff is well trained and current in continuing education.

The plant is locked during normal business hours. A front door buzzer alerts staff of visitors or deliveries. No trespassing signs are posted in front of the plant, and an entry gate and perimeter fencing has been installed. Security cameras of the water plant grounds transmit to the City police department.

Pumpage Data (Million Gallons)	2008	2009	2010	2011	2012	2013	2014
Maximum Daily Demand:	7.26	7.23	6.67	5.83	2.68	1.80	2.62
Average Day For Maximum Month:	6.11	4.94	4.04	4.21	1.95	1.38	2.17
Average Day Demand For Year:	4.83	4.41	3.96	3.14	1.55	1.23	1.72
Minimum Day Demand	3.2	2.7	2.2	0.11	0.89	0.86	0.15
Average Per Capita Consumption: (gpd)	233	213	191	151	122	97	131

Water Treatment Plant

Plant Design Capacity: 12 MGD

State Rated Capacity: 12 MGD

Operational Capacity: 10 MGD (2 filters non-operational at time of survey)

Plant Metering	Y/N	Type
Raw Water:	Yes	two turbine meters
Finished Water:	Yes	Two 20-inch venturi meters
Backwash Water:	Yes	one turbine meter
Plant Water:	Yes	4-inch sensus (type?)

Total Treated Water Storage	MG
Treatment Plant	
Clearwell:	30,000 gallons
Ground Storage:	2 MG (two 1 MG abutting reservoirs)
Distribution System	
Elevated Storage:	0.65 MG elevated storage tank @ Britain & 8th St.
Total (MG)	**2.65 MG**

Percent Of Maximum Day: 40%

Emergency Supply/Interconnections: yes (capacity undefined)
-one interconnection with the City of St. Joseph at M-63 (metered 16-inch main)
-one proposed interconnection with SMRSS&WA at Empire and Woodward (metered 12-inch main)
-interconnections with Benton Charter Township (normally closed and unmetered)

Demand/Capacity/Storage Comments: The water treatment plant (WTP) is rated at 12 MGD which is based on the limiting factors of the firm capacity rating of high service pumping and filtration rates. Maximum day demands over the past decade have been well under 12 MGD. Two filters were out of service at the time of the survey. The effective operational capacity of the WTP at the time of the survey is 10 MGD.

The 2.65 MG of total treated water storage is 67% of average day demands and 40% of maximum day demands and is considered adequate. Average day demands have dropped over the past few years, as the City has lost several large industrial users. The Benton Township water plant construction is complete, and Benton Township is no longer a City customer. Further, St. Joseph Township (Fairplain) disconnected from the City and connected their customers to the City of St. Joseph. These separations have resulted in a reduction in the City retail customer population by approximately 35 percent. Consequently the Euclid standpipe and M-139 ground reservoir are no longer available for the City to depend on. Under normal operational conditions, the ground storage tank at the water plant is not needed for the required chlorine contact time treatment (see appendix C), and has pumping redundancy and stand by power reliability, so the storage capacity is counted for the City storage requirements. Planning for additional elevated storage is recommended. To ensure reliability during emergencies, an emergency agreement with Benton Charter Township and a

hydraulic definition of the Benton Township, St. Joseph Charter Township, and City of St. Joseph interconnections should be obtained.

Water Quality

Data taken from the 2013 & 2014 Monthly Operation Reports

	Raw		Treated	
	Normal	Range	Normal	Range
Hardness, ppm	110 - 160	98 - 250	110 - 150	94 - 202
Turbidity, NTU	3 - 6	0.2 - 60	0.11 - 0.12	0.04 - 0.21
Alkalinity, ppm	120 - 160	87 - 182	130 - 150	88 - 172
Total col., cts/100 Ml	0 - 1519	0 - 16000	< 1.1	< 1.1
E. coli, cts/100 ml	< 1 - 16	< 1 - 82	< 1.1	< 1.1
TOC, ppm	2.0 - 2.6	1.59 - 3.20	1.5 - 2.1	1.50 - 2.10
Nitrate, ppm	not taken	not taken	0.5	<0.4 – 1.5
Fluoride, ppm	0.12 - 0.24	0.01 - 0.66	0.84 - 1.20	0.03 - 1.88
TTHM, ppb	not taken	not taken	45	37 - 64
HAA5, ppb	not taken	not taken	24	20 - 31
pH	7.9 - 8.1	7.0 - 8.7	7.5 - 7.6	6.8 - 8.2

Monitoring Requirements: See Monitoring Schedule; Appendix B

Comments on Water Quality/Monitoring Requirements: Lake Michigan is an abundant fresh water source. The intake can be influenced by weather conditions (wind), seasonal turnover, quick thermal changes, and the St. Joseph River. The finished water produced by the plant generally meets all applicable state and federal drinking water standards.

The worst case of water quality on recent record occurred in September 2011, when a storm produced raw water NTUs ~ 89, while the WTP treated water was around 0.12 NTUs. (In December 1985 a storm produced raw turbidity of around 100 NTUs, but the use of powdered alum and operation procedures at the time allowed plant tap turbidity in exceedance of 1 NTU.) The new plate settlers do not have a very long history at the plant, but plate settlers used at other Lake Michigan plants have a good history of successfully producing low turbid water.

Lake Michigan has a moderate alkalinity concentration that allows stability for coagulant dosages and excellent buffering capacity. Alkalinity levels in both the raw and treated water have seemed to increase by approximately 20 ppm since the last survey, and the hardness has seemed to drop by 20 ppm on average. The slight alkalinity variation does not affect treatment capabilities. The pH does change somewhat in the raw water with limnologic conditions. pH drops during the treatment process slightly (~0.4 units) and the variance seems to follow the lake conditions. The conversion to liquid bleach has resulted in a slightly smaller pH drop during treatment than was experienced using gas.

Natural raw water fluoride levels are characteristic of the Lake Michigan geologic basin and can vary by as much as 0.4 ppm depending on limnologic conditions and influence of the St. Joseph River. This variation can make consistent plant tap fluoride residuals difficult to achieve, but variations are usually adjusted up or down adequately within one day. Fluoride concentration fluctuations do not last long, and at no times has the WTP produced water over 2.0 ppm. Equipment/control failure has been common since the last survey, and fluoridation has not been consistent.

The TTHM and HAA5 ranges are based on available running annual averages (RAAs). The RAA results have remained below 75% of the Maximum Contaminant Level, (MCL), warranting reduced monitoring to one TTHM and HAA5 sample set per quarter. Third quarter (calendar) samples are generally the highest, while first quarter samples are lowest. An Initial Distribution System Evaluation (IDSE) was recently sent to the EPA for approval under Stage 2 Disinfection By-Products Rule requirements.

Occasional positive nitrates occur in source water. It is unknown if there is a strong correlation between spring or local storm run-off and nitrate levels at the intake. The intake has chlorine feed capabilities for zebra mussel control. The intake was not being chlorinated at the time of the DEQ inspection. Routine coliform enumeration is performed weekly at the intake when chlorine is not being fed at that point.

The Long Term 2 Surface Water Treatment Rule (LT2SWTR) required monthly raw water sampling for cryptosporidium, E. coli, and turbidity, from April 2008 to 2010. Sample results placed the City into Bin 1 and no further crypto removal is necessary.

Odor is not monitored at the water plant, nor are algae counts or algae speciation samples taken.

Intake Facility

Name Of Source:	Lake Michigan
Source Capacity:	Unlimited
Diameter Of Intake Pipe:	36-inch steel
Total Length:	3,950 feet from shorewell
Intake/Crib Capacity:	(24 MGD)
Location (Latitude/Longitude):	N 42^0 07.88' W 86^0 29.10'
Submergence:	3375 ft from shore in 42 ft. of water, 27' to top of crib
Entrance Velocity:	5.25 ft/sec at 24 MGD
Grating:	40 - 2"x12" cedar slats placed radially around opening
Zebra Mussel Control:	3" HDPE leading to diffusion ring in base of intake
Historic Low Water Elevation:	576' above sea level (2013)

SANITARY SURVEY EVALUATION FORM

Intake Facility

Historic Low Water Flow:	no measured change
Historic High Water Elevation:	582.5' above sea level (1986)
Standby (Emergency) Intake?	2 - 36" emergency risers at 1500' and 2500' from shore
Is SWAP Available?	yes
Backflush Provisions?	Yes, from finished water clearwell

Comments on Intake: The intake and two emergency risers were last inspected in 2008. Both the intake and the risers were reported to be in good condition. The riser location (lat/long) should be kept on record in the ERP to access in case of emergency. Although chlorine can be fed at the intake to control zebra mussels, it is not currently employed as a cost saving measure. Zebra mussel infestation may reduce the intake capacity somewhat, but not enough to prevent the WTP from keeping up with system demands.

A wet well (~120,000 gals) is located adjacent to the low service pump room. In 1997, a new traveling screen was installed. The motor/gears were replaced in 1999. Also in 1997, a new spool piece was installed on the 36-inch pipe (upstream of the traveling screen) which allows the cone valve (located in a dry well) to no longer be submerged, and allowed the intake line to be back flushed if needed. However, the blow-back valve has been completely removed from service. Piping from the finished water storage can fill the shore well and backflush the intake if needed. The piping is equipped with an air break.

The wet well was last cleaned and inspected in 2012.

Pumps and Pump Locations

Purpose		Location	Capacity (MGD)	Type	Lubricant	Status	Preventative Maintenance	Flooding?
Low Service:								
	#1	plant – 2nd floor	2.0	vertical turbine	oil	active	annually	no
	#2	plant – 2nd floor	3.0	vertical turbine	oil	active	annually	no
	#3	plant – 2nd floor	5.0	vertical turbine	oil	active	annually	no
	#4	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#5	plant – 2nd floor	6.0	vertical turbine	oil	out of service	no	no
	Firm		14 MGD					

SANITARY SURVEY EVALUATION FORM

Purpose		Location	Capacity (MGD)	Type	Lubricant	Status	Preventative	Flooding?
High Service:								
	#1	plant – 2nd floor	2.0	vertical turbine	oil	out of service	no	no
	#2	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#3	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#4	plant – 2nd floor	4.0	vertical turbine	oil	active	annually	no
	#5	plant – 2nd floor	2.0	vertical turbine	oil	active	annually	no
	Firm		12 MGD					
Filter Backwash:								
	#1	plant – 2nd floor	7.5	vertical turbine	oil	active	annually	no
	#2	plant – 2nd floor	7.5	vertical turbine	oil	active	annually	no
Sludge Disposal:		**by**	**gravity**	**sewer**	**to**	**lagoon**		

Location of Pump Switch Gear: Located on the second floor and not susceptible to flooding

Comment on Pumps/Pump Maintenance: Low Service pumps take suction from wet well and discharge to rapid mix (24-inch splits to two-20-inch). High Service pumps take suction from finished water suction well which is connected to a 2 MG treated ground storage tank, and discharges to the distribution system via two, 20-inch mains. Backwash pumps take suction from the finished water suction well. (The water plant cannot backwash from the distribution system.) Surface wash pumps take suction from the finished house water line. Most of the Low and High Service pumps have had either the pump or motors rebuilt within the past 13 years. Pump maintenance/overhaul records are kept by plant staff. WTP pump motors have an annual preventative maintenance program by an outside contractor. High service pump # 5 had the foot valve replaced in 2007.

Treatment Facilities

Rapid Mix
Number of Units: 2
Volume of Each Unit: 8600 gallons each
Detention Time at Rated Capacity: 0.5 to 2.0 minutes
Mechanical or Static? Mechanical –variable speed propeller
In-line or CSTR: CSTR

Velocity Gradient (G) if Available?

Is Mixing Rate Adjustable? yes

Condition of Equipment: new

Chemicals Added: Aluminum Sulfate (alum), Capable of adding polymer

Comment on Rapid Mix: Alum can still also be fed directly into the 24-inch influent line in two places.

Flocculation Basins

Number of Units: 2

Volume of Each Unit: 168,300 gallons each

Three chambered stages, run in series, with adjustable floc paddle speed

Unit Dimensions: 50' x 30' x 15'

Detention Time at Rated Capacity: 40 minutes

Type Of Units: paddle

Inlet Design: baffled

Is Mechanical Flocculator Used? yes

Condition of Equipment: new

Baffles: yes

Baffling Factor: 0.7

Drain: yes

Overflow: none

Curbing: yes

Does A Preventive Maintenance Program Exist? yes

Comment on Flocculation Basins: The new flocculation basins were put into service in 2011. They are three separate mechanical flocculation stages and each is 15-feet long. Each flocculator paddle has a variable frequency drive motor to adjust the paddle speed. Only alum is being used at this time, but the new floc basins have the capability to treat using polymer as well. At the time of the

survey, one motor drive was out of service and awaiting replacement. Settled water quality was excellent.

Settling Basins
Number of Units: 2
Volume of Each Unit: 134,640 gallons each
Dimensions: 40' x 30' x 15'
Detention Time at Rated Capacity: 27.7 minutes at 7.0 MGD
Types of Units: Stainless Steel Plate Settlers at 55^0 inclination
Clarification Rate (gpm/sq. ft.) 0.3 gpm/ft^2
Number of Weirs per basin: one
Total Weir Length: Awaiting as-built drawings
Weir Loading Rate: (gpd/ft)
Inlet Design: baffle wall
Baffles: perforated walls at inlet and outlet
Outlet Design: Effluent Trough Weir
Baffling Factor: 0.5
Overflow: No
Drains: Yes
Curbing: Yes
Sludge Removal Method: scrapers and annual cleaning
Sludge Disposal: Backwash Lagoon – **Needs to be cleaned out**
Physical Condition: new
Effluent Turbidity, average/range: ~ 0.4 - 1.0

Settling Basin Comments: The new plate settlers were constructed under a DWRF project to replace the old decrepit Accelators, and produce settled water that is less susceptible to thermal inversions. The existing raw water piping was rerouted into the new settling basin building from the old plant. A by-pass valve exists around the settling basins. The raw water enters the rapid (flash) mixing chamber, then the 3 flocculation stages. Baffles exist for the inlet and outlet of each flocculation stage. Floc paddle speeds are adjustable by variable frequency drive motors. The water then enters the settling basins filled with plate settlers. The effluent flow then leaves the settling basins over the weirs, where it is piped back to the existing filter building.

Basins can only be operated in parallel or one at a time (not in series). Basin sludge is collected in the sloped floor where scrapers collect it and it is discharged a newly constructed backwash lagoon.

There is a continuous reading turbidimeter on the common effluent pipe from both basins. One settling train was out due at the time of this survey, due to a motor repair. The settling basins have only been in operation a few months, but treated water exceptionally well during a rare period of very poor raw water quality.

Filtration

Type of Filter: declining rate, constant head

Dimension of Each Filter: 18 ft 8 in x 18 ft 8 in

Filtration Area: 349 ft²

Total Filtration Area: 4,200 ft²

Number and Area of Filters: 12 filters total, each has 349 ft² of surface area

NOTE: Filters 1 & 2 were out of service at the time of the DEQ inspection

Design Filtration Rate, gpm/ft²: 1MGD per filter (2 gpm/ft²)

Approved Filtration Rate, gpm/ft²: 4 gpm/ft² on clean filter, 2-2.5 gpm/ft² over entire filter run

Maximum Experienced Filtration Rate, gpm/ft²: 4 gpm/ft²

Is Flow Equalized Through All Filters? yes

Rate Of Flow Device: yes, rate is limited to 4 gpm/ft² by effluent valve in a locked position

Filter To Waste Available? Yes

Filter Drain: yes

Filter Hours: Average: 200 Maximum: 200 Minimum: 8

Summer Average ~ 170 hours

Filter Media - Filters No. 9-12 (new)

	Anthracite	Sand	Gravel
Depth – Inches:	<2	21	14
Effective Size (mm):	0.9	0.45-0.55	
Uniformity Coefficient	1.5	1.25	

Filter Media - Filters No. 1-8 (new)

	Anthracite	Sand	IMS cap
Depth – Inches:	6	22	
Effective Size (mm):	0.95-1.05	0.45-0.55	
Uniformity Coefficient	< 1.7	< 1.6	

Date Last Rebuilt or Checked: Filters 3, 4, 7 - 1995, new media and underdrains
Filter 8 – 1997 new media and underdrain
Filters, 1, 2, 5, 6, - 1998, new underdrains

Filters 5, 6 – new media in 2002
Filters 9, 10, 11, 12 – 2011 new underdrains

Underdrain Type: Filter 9-12 Leopold blocks with 1-inch IMS cap
Filters 1-8 Leopold blocks with 1-inch of IMS cap

Curbing: yes; front and back

Filter Overflow: back to settling basins

Surface Wash: valve actuators out of service at time of survey

Surface Wash Source of Water: in-plant process (treated) water

Air Scour: no

Depth of Water above Media: 63-inches for old filters, 64-inches for new filters

Filter Performance Records: turbidity records being kept for three years

Turbidimeters

Is There Continuous Turbidimeter For Each Filter?	Yes	Calibration Frequency: monthly
Is There Continuous Turbidimeter For The Applied?	Yes	Calibration Frequency: quarterly
Is There Continuous Turbidimeter For Confluence?	No	Calibration Frequency: N/A
Turbidimeter Used For Combined Compliance:	Hach 2100N	Calibration Frequency: monthly

Comments on Filter Construction/Maintenance/Turbidity Measurements: Filters are declining rate, constant head and have an effluent valve that is "locked" in position, allowing up to 4 gpm/sq.ft on a clean filter. A spring loaded valve adjustment is located on the filter control panel console where the operators manually initiate the flow rate, usually about 2 gpm/sq.ft. and then adjusted throughout the filter run in order to maintain 2 gpm/sq.ft. as head loss rises.

Filters No. 9, 10, 11, and 12 have been rebuilt with the current DWRF project. The City has replaced all filter influent valves and all 6 filter drain valves (which drains the gullet and media of the entire filter unit).

Filters 3 & 4 were backwashed during inspection. The spray arm wash did not activate as apparently the control valves did not work. The spray arm direction flags leaked water during the backwash cycle.

The on-line turbidimeters are Hach model 1720Es. The plant has two CFE grab sample locations for compliance purposes. The South CFE which includes effluent from Filters No. 3, 4, 7, 8, 11, 12, and the North CFE which includes effluent from Filters No. 1, 2, 5, 6, 9, 10. A single sample tap for both South and North CFE would better represent the effluent from all the applicable filters and reduce compliance monitoring points, however due to buried piping a sampling location is not available.

Backwash:

Average Run Length Time of Filter: ~ 200 hours

Criteria for Backwash: 200 hours or 1.0 gpm/ft² or 0.3 NTU

Source of Backwash Water: clear well (treated water)

Average Duration of Backwash: 5 – 10 minutes, ~45,000 gallons per wash

Maximum Duration of Backwash: 10 minutes

Average Backwash Flow, gpm: 5200 gpm

Maximum Backwash Flow, gpm: 5500 gpm

Maximum Backwash Rate - gpm/sq.ft: 15.7 gpm/ft²

Rise Rate, in/min: - 253.3 in/min (5500/349 = 15.76 x 12/7.48)

Is Bed Expansion Achieved? Filters 1-8 yes, filters 9-12 yes

Loss of Media during Backwash? minimal

Backwash Disposal

Backwash Water Discharge Location: lagoon with overflow to surface water

Is Backwash Water Recycled? no

Associated Problems With Filters:
(Check All That Apply)

Air Binding - occasionally	Media Growth - no
Cementing - no	Media Attrition - no
Gravel Mounding – no	Bacteria Growth - no
Media Loss - little	Uniform Backwash – no, swelling observed
Adequate Backwash Rate - yes	Mudballs - no

Filter Operation Comments: The filters are backwashed at a maximum of 200 hours, 1.0 gpm/sq.ft or 0.3 NTU, which ever comes first. The 200 hour-maximum is the most common criteria. Mandatory filter run limits are imposed during difficult treatment times, i.e., filter runs of only 50 - 60 hours if applied turbidities are high. Also, if a filter has over 50 hours of operation and is shut down for any reason, it must be backwashed prior to being placed back in service. The new plate settlers have provided consistent low applied turbidity and improved filter run times.

Air binding used to be a problem until air release valving was installed on the backwash header in the early 1990's.

Recent construction added filter-to-waste piping. The filter-to-waste piping is controlled by 4-inch automatic butterfly valves that dump filtered water into a drain pipe under each bank of filters. The drain pipe then flows onto an air break before entering the backwash drain under the floor. The air break splashes a bit during backwash operation.

Backwash water enters the lagoon for evaporation/soil percolation and sludge accumulation. Sludge removal occurs approximately annually. There is an overflow with NPDES permit to the adjacent golf course pond; however the discharge has not overflowed since construction in 2012.

Plant Treated Water Storage/Clearwell

Location: adjacent to the plant

Size: 2 MG total, divided into two 1 MGD halves

Percent above Grade: 0%, completely buried

Low Water Level: 8-feet from bottom

Isolation Capabilities: each section can be isolated and/or by passed

Vents: yes, all screened

Reservoir Baffling: exit wall diffuser, baffling factor = 0.3

Drains: each section has sloped floors with a slump

Overflow: yes, into high service suction well.

Overflow screened: yes

Access Hatches: yes, overlapping tight covers

Alarms: none

Last Inspection: east half, 2004; west half 2008

C*T Applied or Applicability: reservoir not needed to maintain adequate C*T

Comments on Treated Water Storage/Clearwell: Half of the finished water reservoir (east half) was drained and inspected in 2004. Some sand and alum was evident, but overall the reservoir was in good shape. The west half was inspected in 2008, and found to be in good structural shape. Each half of the reservoir is properly vented, and the vents are screened.

The 12-inch isolation valve was recently replaced to allow isolation of the reservoir halves and should be regularly exercised to ensure future operation.

The inlet/outlet valve vaults fill with water, and plant staff pump the vaults out as necessary. The entry hatches were recently replaced with stainless steel hatches with overlapping covers.

The high-service pump clearwell (suction well) is accessed from the basement of the plant. The entry hatch is rusted, holy, and flat with the floor. Surge valves are being removed with the new project. Pipes that dump into the clearwell will remain and be capped. A possible interconnection between the surge piping may allow transmission reliability outside of the plant.

Chemical Feed

Chlorine
Chemical Supplied: sodium hypochlorite 12 ½ % delivered by truck load (5600 gallon delivery)
UL/NSF Approved? yes

Standard 60 Max Dose:

Supplier: Alexander Chemical – Michigan City, Indiana 1 800 348-8827

Chlorine Feed Points:

1) intake – intermittent use
2) raw water – low service pump discharge*
3) raw water - rapid mixer
4) applied – each settling basin effluent
5) treated – high service pump discharge header*

*normal feed points

Chlorinators

Chlorine Feed Dosage Determination: $\frac{\text{(gallons liquid chlorine) x (\% of available chlorine) x (density)}}{\text{Million pounds of water pumped}}$

Chlorine Room

Description: Bulk chlorine storage room is located in a separate building south of the plant. Three bulk tanks of 2,800 gallons each are provided. Two tanks are filled per delivery (5,600 gallons). Transfer pumps provide chlorine to two day tanks; a 50 gallon and a 200 gallon. Transfer pump switches are located next to the day tanks and are equipped with "dead-man" operation (switch has to be held in the on position to work). The chlorine day tanks are equipped with scales.

Scales: yes – calibrated at installation

Minimum Days of Storage: ~ 60

Chlorine Safety Features/Summary: (*Check All That Apply*)
("both" indicates both the bulk storage room located in a separate building and feeder room located in plant)

☒ Panic Hardware
☒ Chlorine Leak Alarm ☒ Haz-Mat Team
☒ Inside Access feed room only
☒ Outside Access yes -
☒ Doors Open Outward ☐ Repair Kit
☒ Heater ☒ Ventilation
☒ Window ☒ Air Supply
☒ Scales ☒ Fan Switches

Chlorine Comments:

The water plant recently switched to liquid chlorine. The bulk liquid chlorine feed system consists of three bulk tanks located in the chemical storage building across from the plant. Fill ports are clearly marked. Chlorine concentration (density) is measured and some degradation is seen during the summer months. On March 11, 2014, the chlorine feed was left on overnight while the plant was shut down causing an overfeed. The problem was discovered the next day at plant start-up, but the settling basin volume has prevented the chlorine concentration from exceeding 3.5 ppm.

Alum

Chemical Supplied: Liquid aluminum sulfate

UL/NSF Approved? yes

Standard 60 Max Dose: 150 ppm as product

Chemical Feed Point: raw water rapid mixer

Supplier: General Alum Corporation

Chemical Feeders:

	Model	Max Feed Rate	Min Feed Rate
1	hydroflo CJ4T1131205014	21.58 gph @ 60 psi	95 ml/min
2	hydroflo CJ4T1131205014	21.58 gph @ 60 psi	95 ml/min

Chemical Feed Dosage Determination: usually raw water and applied water turbidity

Alum Dosage Calculation: done properly

Feeder Calibration Frequency: monthly

Scales? No, tank content is determined by sight glass gauge tube and read in inches

Alum Storage

Bulk Storage: two-3,800 gal tanks

Minimum Days of Storage: 45

Transfer Pumps: 2-Thompson Mag pumps, 3/4 Hp, rated 25 gpm @ 20' TDH

Day Tank: 1-300 gallon tank filled manually by operators

Scales:

Level alarms in bulk or day tanks?:

Spill Protection: yes

Piping Identification: yes

Overfeed Protection: Fill line from bulk storage is air-gapped. Dead man fill switch on day tank.

Alum Comments: The alum feed system is well designed and is working properly with very few problems over the past few years. Alum dosage is reported on the MOR's as AL^{+3} ion and the dosage calculations have been reviewed and are correct. There appears to be an anti-siphon device located on the chemical feed pump, but this should be verified. The alum feed pumps are electronically interlocked with the low service pumps. The day tank is filled manually, with an overflow cut-off switch to prevent overfilling. A dead man switch was recently installed on the day tank transfer pumps.

Fluoride

Chemical Supplied: Fluorosilicic acid (H_2SiF_6), 19.8% actual fluoride

UL/NSF Approved? yes

Standard 60 Max Dose: 6 mg/l as product

Chemical Feed Point: settled water effluent prior to filters

Chemical Feeders:

	Model	Max Feed Rate	Min Feed Rate
1	1 LMI F-C711-715	36 gpd @ 150 psi	30 ml/min

Chemical Feed Dosage Determination: adjusted to achieve plant tap residual of 1.0 mg/l

Fluoride Dosage Calculation: done properly

Feeder Calibration Frequency: monthly

Scales: yes - for day tank

Fluoride Storage

Bulk Storage: 5,700 gal tank

Minimum Days of Storage: 120

Transfer Pumps: One-56 gpm @ 56' TDH

Day Tank: 75 gallons filled manually with air gap

Spill Protection: yes

Piping Identification: yes

Overfeed Protection: yes

Fluoride Comments: The fluoride feed pumps are started and stopped by having them electronically interlocked with the low service pumps and are manually adjusted. No flow-pacing of chemicals exists. There is mechanical and electrical redundancy built into the system with a flow switch that energizes the feed pump. There appears to be an anti-siphon device located on the chemical feed pump, an additional one at the point of application. A dead man switch was recently installed on the day tank transfer pump.

Fluoride dosage calculations were reviewed and showed correct during the previous sanitary survey.

The transfer pump has been inoperative for several months since the last survey due to control issues, and has resulted in lack of fluoridation for several months. Controls should be repaired to ensure consistent fluoridation.

Other Chemical Additions

Carbon: none

Polymer: newly installed, not yet operational

Lime/Soda Ash: none

Taste and Odor Control: none

Comments on Other Chemicals: No other chemicals besides chlorine, alum and fluoride are currently used at the plant. The water plant is considering polymer addition for the plate settlers per manufacturer recommendation.

Carbon addition was routine operation prior to installation of the old Accelators in the mid-60's. The feed lines are still installed in the low service line to the clarifiers, but are no longer used.

Plant Piping and Miscellaneous

	Pipe Diameter	Length
Intake Pipe:	36 - inch	
Low Service Discharge:	24 – inch (splits into two 20-inch pipes)	
Settled Water Effluent:	36-inch	
Filtered Water Effluent:	30-inch	
High Service Suction Header:	36-inch	
High Service Discharge:	2 @ 20-inch	
Backwash:	24-inch	
Surface Wash:	4-inch	
Wash Water Drain:	24-inch to 30-inch sewer	
Intake Backflush Line:	12-inch REMOVED FROM SERVICE	
Sludge Drain:	24-inch	
Plant Service to Chlorine Feeders	2-inch	
Plant Service Line:	6-inch	

Do Any Roof Drains or Other Drains Enter Treatment Process? no

Pipe Color Coding: all pipes are currently color coded

Plant Cross Connections And Common Walls:

Filter Gullets? Yes, bottom of gullets is the same elevation as bottom of filter media

Common Walls? None (except for the one in the filter gullets)

Chlorine Feed Room? none

Plant Water RPZ? yes

Chemical Feed Areas? none

Surface Wash? RPZ on surface wash header line

Boiler? Removed from Service 2011

Comment on Plant Piping Miscellaneous: Piping is currently color coded (with flow direction arrows); and rusted pipes, flanges, nuts and bolts either replaced or repaired.

A high service discharge pipe burst in September 2007, flooding the basement. A staff person from the Ductile Iron Pipe Research Association (DIPRA) assessed the failed pipe, and the final DIPRA report stated that the pipe was in sound shape and the failure was due to unusual hydraulic conditions.

RPZ's are tested every year by a certified tester. All hose bibs and slop sinks have vacuum breakers installed and the eye wash stations are protected by the RPZ on the plant water service line. There is no dishwasher in the plant. Dehumidifiers are located in the pipe gallery.

All filter wash hoses are rated for potable water (NSF Std. 61).

A WTP valve program has been started. Valves are being inventoried, cataloged, and turned. An automatic valve actuator is available to staff.

Roof drains once dumped onto the filters but were rerouted along the filter room ceiling to the outside. Occasionally the roof drain pipes will leak, but are immediately repaired.

Plant Metering and Controls

Plant Water: meters for backwash water and in-house water use

Raw Water Metering: 2 - one on each settling basin influent line

High Service Metering: 2 - one on each 20-inch line, accuracy is questionable

Backwash Water: one turbine meter

Plant Controls: Pump operation via SCADA from operation room

Chemical Feed: all rates are manually adjusted

Chlorine: manual

Alum: manual

Fluoride: manual

Chemical Transfer Pumps: manual

Filters: starting and stopping filters is done manually at filter control panel

Filter Backwash: done manually according to pre-determined criteria

Low Service Pumps: manual based clearwell levels (level not to drop below 10')

High Service Pumps: manual based on elevated storage tank levels

Elevated Tanks: levels are maintained according to pre-determined criteria

Security: Plant is fenced on 3 sides and staffed 24 hours a day. Doors are locked at all times.

Flexibility In Operation: Pretreatment units (settling basins) can be bypassed or run individually. Filters cannot be bypassed (plant bypass). Filters are piped in pairs and can only be serviced or taken off-line as such.
The entire finished water reservoir (except suction well) can be bypassed.

Plant Alarms *(Check all that apply)*:

- ☐ Basement Flooding
- ☒ Chlorine Leak
- ☒ Chlorine Supply
- ☒ Low Service Intake Well
- ☒ Pretreatment Basin Levels
- ☒ Elevated Storage Tanks
- ☒ Filter Level
- ☒ High Service Pump Discharge Pressure
- ☒ Pretreatment Sump Pump Failure
- ☐ CFE Turbidity
- ☒ Chemical Tank Levels
- ☒ Main Control System Failure
- ☒ UPS Power
- ☒ Finished Water Reservoir
- ☒ Individual Filter Turbidity
- ☒ Elevated Tank Loss of Signal
- ☐ Intrusion Alarms

Comments on Plant Metering and Controls: The raw water, plant domestic water and treated water meter all have totalizers which are read every day. The raw water being treated is metered at both settling basin influent lines.

Also, the treated water (high service pump discharge) meters have not been calibrated for many, many years. The water being pumped out to the distribution system is currently being determined by subtracting the plant usage water from the raw water pumpage.

SCADA system has been upgraded to include turbidity measurements from individual filters that can be observed by the operators in the control room. As an example, an alarm can sound or trip when turbidity from any filter reaches 0.3 NTU. This will alert the operator, who in turn can take corrective action before an individual filter "trigger" is exceeded. Failure to act promptly in this situation could lead to expensive engineering evaluations required by the Interim Enhanced Surface Water Treatment Rule.

Valve Operation:
Are Critical Valves Exercised On A Routine Basis?

Valve Location	Exercised?
Intake Valves	Yes
Intake Backflush Valve	no longer in service
High Service Isolation Valves	Yes
Clearwell Valves	Yes
Influent/Effluent Pretreatment Basins Valving	Yes
Effluent Flume Valve	Yes
Low Service Pump Discharge Valving	Yes

Interruptions in Operation: In November 2000, the plant lost power for about 6 hours when the dedicated substation located next to the plant (not the 2 substations out in the power grid) failed. During May of 2004, a major city-wide power outage lasted 28 hours. The water plant was without power and the distribution system lost pressure for about 18 to 20 hours in several locations even though the distribution interconnection with the City of St. Joseph was in operation. This incident showed that the water plant did not have a reliable power source from the local utility and the water system could operate effectively during power outages. A dedicated auxiliary generator was installed to operate the water plant in the event of a power outage under a DWRF funded water project. The generator is working satisfactorily.

Laboratory

Parameter	*Method	Calibration	Sample Points	Sample Frequency
Alkalinity	Titration (2320)	monthly	1) raw water 2) applied 3) plant tap	twice daily twice daily twice daily
Chlorine	DPD (4500 F)	monthly	1) settled 2) applied 3) filtered 4) plant tap 5) dist syst.	every 2 hrs every 2 hrs every 2 hrs continuously **w/ bacti sample**
Fluoride	SPADNS (4500 D)	twice daily	1) raw 2) plant tap 3) dist syst.	daily daily w/ bactis
Hardness	EDTA titrimetric (2340 C)	monthly	1) raw 2) plant tap	twice daily twice daily
pH	electrode (4500 B)	twice daily	1) raw 2) applied 3) plant tap	twice daily twice daily twice daily
Temp.	elec. thermometer	monthly	1) raw 2) plant tap	continuously twice daily
HPC	Pour Plate (9215B)	monthly	1) raw 2) Plant tap	daily daily
Turbidity	Hach 2100p Hach 2100p Hach 1720E Hach 2100p Hach 2100p	monthly monthly monthly monthly monthly	1) raw 2) applied 3) ind. filter 4) CFE 5) Plant tap	every 2 hours every 2 hours every 10 mins every 2 hrs grab every 2 hrs grab
Coliform	MTF on Raw, Tap colilert on dist. sys (9223 & 9221)	monthly QA/QC	1) raw 2) plant tap 3) dist sys	daily daily per plan

Numbers in parentheses refers to AWWA Standard Methods number

There are continuous monitoring turbidimeters on the low service discharge (raw) and combined settled effluent which are read every 2 hours. Continuous monitoring turbidimeters are located on each of the operating filter effluent lines which record turbidity levels every 15 minutes to a database.

Laboratory Certification: Lab is certified for Total Coliform, *E. coli* and HPC analysis. Certification expires July 14, 2018.

Comments on Laboratory: The laboratory is inspected by DEQ Remediation and Redevelopment Division and the certificate displayed in a conspicuous place. The lab has also earned a Certificate of Excellence in proficiency testing for coliforms from ERA lab testing.

The lab sink taps were labeled at the time of the DEQ survey inspection.

Once a year, all lab equipment is inspected and calibrated in accordance with the QA/QC plan by a third party.

Odor is not tested for in the laboratory, nor are algae counts or algae speciation performed.

WATER PLANT - OBSERVATIONS, CONCLUSIONS, AND RECOMMENDATIONS

Basic Data:

The City's Treatment Plant is a 12 MGD conventional treatment plant practicing coagulation, flocculation, sedimentation (via plate settlers), filtration and disinfection. The 12 MGD rating is based on the limiting factors of high service firm capacity and maximum approved filtration rates when all filters are in working order. At the time of the survey, two filters were not operational, nor was low service pump #5 (6.0 MGD) and high service pump #1 (2.0 MGD), yielding an effective treatment rate of 10 MGD. The majority of the plant was constructed in 1950, with several improvement projects completed since the original plant went on-line. The City recently improved treatment by constructing plate settlers in two separate treatment trains, installing filter-to-waste piping, rehabilitated filters 9 – 12, and installed a stand-by generator that can operate the entire plant during interrupted utility power. The City also constructed a backwash lagoon for backwash disposal, and converted to liquid chlorine from gas for safety reasons.

The plant process description starts with raw water flowing via gravity from the intake to the low service wet well, where low service pumps lift the water (after flowing through traveling screens) to the two parallel flocculation basins and settling basins. Liquid chlorine is injected at the low service pump discharge line and alum is added in a flash mixer just prior to the flocculation tanks and settling basins. The settling basins provide sedimentation through inclined plate settlers. Fluoride is added to the settled water which then flows to the filters. Filtered water then flows via gravity to a 2 million gallon finished water reservoir. High service pumps then pump treated water from a suction well which is adjacent to the reservoir, where chlorine is added again before being sent to the distribution system.

The old the pretreatment units (clarifiers) have been removed from service and replaced, hopefully eliminating the plant's vulnerability to thermal inversions. Good success has been achieved by similar plate settling installation at other Lake Michigan water plants.

Rules and Regulations: Since the late 1980's the Federal Safe Drinking Water Act has been amended several times to include rules that specifically apply to water plants using surface water or groundwater under the direct influence of surface water. These rules and the years they were promulgated are:

- Surface Water Treatment Rule (SWTR) - 1989
- Interim Enhanced Surface Water Treatment Rule (IESWTR) - 1998
- Filter Backwash Recycling Rule (FBRR) - 2001
- Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) - 2002
- Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) - 2005

These rules and subsequent rules promulgated by the DEQ under the authority of the Michigan Safe Drinking Water Act, 1976 PA 399, as Amended, require the following of surface water treatment plants:

1. Maintain a disinfectant residual through the treatment process sufficient to inactivate Giardia and viruses. As currently operated, the plant complies with disinfectant residual contact time (C*T)

requirements. The C*T calculation was updated as part of this survey to include the extra detention time in the settling basins. The C*T calculation was not updated however, to include the finished water pH changes as a result of the upcoming switch to liquid chlorine. No detrimental changes are expected as other Lake Michigan water plants have successfully switched to liquid chlorine. Once a steady trend of water quality results are obtained, the C*T calculations will again be updated. Current C*T calculations are included in Appendix C.

2. Rule 325.10720 requires that a residual disinfectant concentration entering the distribution system be no less than 0.2 mg/L. Water suppliers must report to the DEQ by the end of the next business day if the residual was below 0.2 mg/L. This requirement is being met in the City with chlorine.

3. As further noted by Rule 325.10720, equipment must be provided to continuously monitor the chlorine residual leaving the plant. The required equipment is installed and operating satisfactorily.

4. Residual disinfectant in the distribution system measured as total chlorine shall not be undetectable in more than 5 percent of the samples each month, or HPC counts must be no more than 500. Distribution residuals must be measured and reported whenever coliform samples are collected. This requirement is also being met with chlorine.

5. Again, as noted by Rule 325.10720, turbidity determinations must be made at least once every 4 hours on samples representative of filtered water while the plant is in operation. A single monitoring point at a location containing effluent from all filters, but prior to storage is ideal for compliance purposes. The compliance points are the North Filter Flume (Filters 1, 2, 5, 6, 9, 10) and the South Filter Flume (Filters 3, 4, 7, 8, 11, 12) because piping is not provided such that a single filter confluence sampling tap may be installed. For compliance purposes, turbidity samples are collected from each of these two CFE locations once every 2 hours. Both compliance points must be less than or equal to 0.3 NTU in 95 percent of samples each month, and at no time exceed 1 NTU. On two past occasions, July 2002 and July 2003, the plant has exceeded the 1 NTU requirement. Careful management of alum dosages and a switch to plate settlers have prevented any further exceedances.

6. Finally, the MSDWA requires that individual filter turbidity be monitored and recorded every 15 minutes. This information must be recorded and maintained for three years to determine compliance with "triggers." The individual filter monitoring and tracking system is operating and performing satisfactorily.

7. The Stage 1 of the Disinfectants/Disinfection Byproducts Rule (DBPR) also became effective January 1, 2002, for surface water plant serving over 10,000 people. This rule reduced the maximum contaminant level (MCL) for total trihalomethanes (TTHM) to 0.080 mg/L and set a MCL of 0.060 mg/L for total haloacetic acids (HAA5). In addition, a maximum disinfectant residual level (MDRL) for chlorine was established. A review of the MORs and chemical sample results indicate that these water quality standards are being met.

8. The Stage 2 DBPR will require MCL compliance at all TTHM and HAA5 sampling locations rather than averaging results across the system. The rule also requires any water system using chlorine or other disinfectants to complete an Initial Distribution System Evaluation (IDSE). The city has met the IDSE requirements to date by completing a Standard Monitoring (SM) program and submitting a SM Report to the DEQ. The report has been approved and the city is following the TTHM and HAA5

sampling protocol specified starting in October, 2013. Due to a drastic reduction in demand and resulting longer detention times, the city has exceeded the DBP standard at one of their sites.

9. The LT2ESWTR requires *Cryptosporidium* treatment for certain vulnerable plants. Based on the *Cryptosporidium* monitoring completed at the plant from April 2008 to March 2010, the water treatment plant was classified as Bin 1 and does not have to install additional treatment. A second round of *Cryptosporidium* monitoring must be completed starting in October, 2016.

Source of Supply:

Lake Michigan is an unlimited source of fresh water and is considered an excellent source of raw water for municipal water treatment plants. The intake is impacted by wind direction, wind velocity, changing water temperature, seasonal temperature inversions and to some extent, the St. Joseph River.

There is one interconnection with the City of St. Joseph that will provide some limited reliability in emergencies. Another interconnection has been removed from service. Interconnections exist with Benton Charter Township, and the Township will soon have their own source. The amount of water that can be delivered through the existing St. Joseph interconnection is unknown and should be evaluated. The interconnections with Benton Township should be evaluated hydraulically and an emergency use agreement formed. Also, the valves at the interconnections should be exercised annually to make sure they are in adequate working condition.

A source water assessment for the water supply has been completed by the USGS and the DEQ. A final draft report entitled "Source Water Assessment Report for the City of Benton Harbor Water Supply" was completed in the April 2002. The report determined the source water to be "moderately sensitive".

Intake Facility and Wet Well:

The intake draws water 3,375-feet from shore, under about 27-feet of water (from the top of the crib), making it a moderately sensitive intake. There are two, 36-inch diameter emergency risers, located 2,500-feet and 1,500-feet from shore, 23.5-feet and 12.5-feet below the surface, respectively. The capacity of the intake is 24 mgd at an entrance velocity of 5.25-feet/sec. Lack of zebra mussel control has reduced the intake capacity somewhat, but not enough to interfere with water system demands.

The crib and emergency riser closest to the intake are inspected approximately every other year, with the last inspection being completed in 2007. Both the crib and riser are believed to be in good condition. During the next inspection, the flanges on both emergency risers should be removed to determine the risers' availability during emergencies.

Chlorine is being applied at the intake crib via a 3-inch HDPE feed pipe to prevent zebra and quaaga mussel infestation. Mussel infestation is reportedly evident at the intake. No infestation is visible in the wet well. In 1997, a valve and spool piece was installed on the 30-inch raw water line which allowed the intake pipe to be backflushed. However, backflushing of the line has not been necessary, and the valve between the intake and high service line was removed. Also, the intake line should be regularly inspected and cleaned if necessary.

The traveling screens in the wet well were replaced in 1997 and new motors/gears for the screens were installed in 1999.

Information and Control System:

Most, if not all of the plant functions are manually operated and/or controlled. The main control room and panels in the plant currently allow operators to adequately control and monitor the plant and distribution system. Alarms are present which will notify operators of potential problems throughout the plant. The main control room has some limited supervisory control and data acquisition (SCADA) systems. Individual filter turbidities measurements are recorded via a SCADA system.

Pumps and Pump Locations:

Proper functioning pumps are essential to the efficient operation of the plant. Pumps that fail to operate, or do not operate as designed, waste operator time and system resources. It is important that the pumps be tested, serviced, and maintained. Detailed records should be kept for these activities. While a majority of the pumps have either had the motor or pumps rebuilt in the past 10 years, a preventative maintenance program should be established for each pump. As a minimum, the plan should include, but not be limited to, all of the following:

1) Basic pump information including the make, manufacturer, pump operating speed, design capacity including pump curves, horsepower of the motor, and pump and motor efficiencies.

2) Actual pump capacity, alone and in combination with other similar use pumps. This information should be recorded and maintained by plant staff so that system demands can be met using the most efficient combination of pumps. This information should be updated at least once per year.

3) A record of all work performed on the pump, including scheduled as well as unscheduled maintenance. The record should indicate the date the work was performed, the nature of the work, and the name of the individual performing the work.

4) An evaluation of the actual current draw for each motor and comparison with original installation or design conditions. Motor efficiencies should be verified at least once per year with appropriate records maintained.

Five low service pumps with a 14 MGD firm capacity lift the raw water from the low service wet well and discharge to a 24-inch pipe which then splits to two, 20-inch pipes that flow to the settling basins. The pump motors and electrical switch gear are located on the second floor of the plant and are above the 100-year flood plain and not subject to flooding. Adequate valving is provided which allows each low service pump to be isolated for maintenance or other purposes. Low service # 5 is out of service indefinitely. The low treatment demands do not dictate necessity to repair the pump at this time.

Five high service pumps with a 12 MGD firm capacity pump treated water from the finished water suction well adjacent to the treated water reservoir and discharge to two, 20-inch mains that lead to the distribution system. The pump motors and electrical switch gear are located on the second floor of the plant and are above the 100-year flood plain are not subject to flooding. A catastrophic pipe failure in 2005 flooded the basement but the water did not raise enough to affect the switch gear or prevent pump operation. Adequate valving is provided which allows each high service pump to be

isolated for maintenance or other purposes. High service # 1 is out of service indefinitely. The low treatment demands do not dictate necessity to repair the pump at this time.

The plant relies on two backwash pumps to backwash the filters. These pumps take suction from the finished water suction well. The backwash rate available from either pump is adequate to clean the filters. These pump motors and electrical switch gear are also located on the second floor of the plant and are not susceptible to flooding.

Pretreatment:

The two circular Infilco Accelators pretreatment basins have been removed from service due to the poor physical condition of the steel and inability to properly prevent floc from entering the treatment train during thermal inversions. Plant pretreatment now consists of rapid mixing, 3-stage flocculation, baffling, and settling basins with inclined plate settlers. Currently the only coagulant being used is alum, but has the capability to add both polymer and alum. The new pretreatment process has demonstrated the settled water quality to date is excellent.

Filtration:

The plant has 6 filtration units, each with two cells for a total of 12 "filters". For ease of numbering and explanation, the plant is considered to have 12 filters. The filters are declining rate, constant head and each unit has an effluent valve which allows a maximum filtration rate of 4 gpm/sq.ft. The normal or average filtration rate is 2 gpm/sq.ft, which equals 1 MGD for each filter.

Filters No. 9 - 12 underdrains and media have been recently replaced and were out of service at the time of this project. Filters No. 1 - 8 have Leopold filter underdrains with a 1-inch IMS caps that were installed in either 1995 or 1997. New media was installed in Filters No. 3, 4, 7 in 1995, in Filter No. 8 in 1998 and Filters No. 5 and No. 6 in 2002. Filters No. 1 and No. 2 have original media.

The City has replaced all the filter influent and filter drain valves located in the filter piping gallery and has installed filter-to-waste piping for each filter. Also, the paint on the ceiling in the filter gallery has been repainted.

Treated Water Storage:

The 2 million gallon ground storage reservoir consists of two one-million gallon compartments or sections. Each section can be individually isolated or the entire reservoir can be by-passed if needed. Under normal operation, finished water from the reservoir flows to the suction well where the high service pumps then deliver the water to the distribution system.

The east half of the reservoir was inspected in 2004 and the west half in 2008. Both were found to be in generally good shape. All vents, screens and access hatches are in adequate condition and do not allow insects, bugs or drainage water into the reservoir.

Chlorine Feed:

The chlorine feed system consists of bulk liquid chemical storage (three 2500-gallon tanks) located in a separate building and 2 displacement feeders located on the first floor of the plant. Normal application of chlorine is to the low service pump and high service pump discharge lines. Other feed points are available, but rarely used.

Two cylinders are "on-line" at any one time, with one cylinder being in the lead position and the second one acting as a backup. When the lead cylinder is empty, the system will automatically switch to the backup cylinder. Both of these cylinders are on scales to determine chlorine feed dosages. Changes to the chlorine feed rate are done manually by the operators, which is based on maintaining a residual in the applied water of at least 1.2 mg/l and at the plant tap of at least 1.5 mg/l.

Alum Feed:
The alum feed system consists of two 3,800 gallon bulk storage tanks, two transfer pumps, one 300 gallon day tank (no scale) and two chemical feeders and is operating satisfactorily. The transfer pumps are operated manually by a switch within the chemical feed room in the plant. Switch automatically turns off when the day tank float control indicates a full tank.

The alum feed pumps are interconnected with the low service pump circuitry and there is an anti-siphon valve on the discharge line of the feed pump. Normal alum feed point is in the rapid mixer to the new settling basins, but they still can add alum on the raw water line just prior to entering the settling basins. Dosages are manually adjusted by the operators and are calculated by a formula which is based on inches of drawdown in the bulk storage tank via a sight glass. The calculations have been reviewed and appear to be accurate. It may be beneficial to place the day tank on scales to more accurately measure and calculate alum dosages. The day tank overflow drains to surface water. A dead-man switch was recently installed to prevent alum overflow in the event the float control switch fails.

Fluoride Feed:
The fluoride feed system consists of a 5,700 gallon bulk storage tank, transfer pump, 75 gallon day tank (with scale) and a chemical feed pump. The transfer pumps are operated manually by a switch within the chemical feed room in the plant. The day tank fill line is air-gapped to prevent massive overfeeds.
The fluoride feed point is on the settling basin effluent line just prior to entering the filters. Dosages are manually adjusted by the operators and are calculated by a formula which is based on scale readings. The calculations have been reviewed and appear to be accurate.

The fluoride feed system has a redundant electrical activation mechanism to prevent over feed. Fluoride overfeeds have occurred at other water plants because of failure of a single electrical activation mechanism. Redundant fluoride feed activation mechanisms must be provided because of the hazardous nature of high concentrations of fluoride. The fluoride feed pumps are interconnected with the low service pump circuitry. However, a redundant safety mechanism, such as a flow switch must also be interconnected with the feed pump circuitry. This should assure that no chemical feed pumps will operate unless water is flowing and the low service pumps are energized.

Also, anti-siphon valves should be installed not only on the chemical feed pump discharge lines, but also at the point of application to prevent overfeeds from occurring due to siphoning.

Plant Piping and Miscellaneous: The piping within the plant is cast iron and steel. Chemical piping is primarily PVC. The majority of the piping within the plant is rusting; and some severely. Many of the nuts and bolts securing the flanged joints are also severely corroded. While some nuts and bolts have been replaced in the past few years, staff needs to be diligent in replacing these items on a consistent basis. Also, all pipes, drains, and chemical feed lines are being repainted and they will be

color coded in accordance with "Recommended Standards for Waterworks, 2007 Edition." Flow direction arrows will also be labeled on the pipes.

The City has recently replaced all the filter influent and filter drain valves located in the filter piping gallery, and recently installed filter-to-waste piping for each filter. The City is encouraged to award the bid to a qualified contractor and proceed with the filter-to-waste project as soon as possible.

Cross connections were found to exist in the chemical feed room and at the filter gullets as a result of the survey. All have been discussed with suggested remedies in other parts of the survey and will not be repeated here.

Plant Metering and Controls: The high service pump meters were out of service at the time of the survey due to construction. Currently, finished water pumpage is calculated by subtracting in-plant water use from raw water meter data. The high service pumps have lacked routine calibration in the past and need to be calibrated routinely.

A routine plant and yard valve exercise program has been started. Each valve has been inventoried and given a number, location, type and function. Each valve should be tagged to identify its function. Plant staff have access to an automatic valve actuator and should be familiar with the location and operation of all yard valves.

Laboratory: The laboratory at the water treatment plant has been certified for analysis of total coliform, *E. coli* and HPC in the past, but the certificate was not on display, and the staff did not know the certification status. The analyses, equipment, and monitoring frequencies have been presented earlier in the report. Since the laboratory is inspected by DEQ RRD, no evaluation of the equipment and procedures currently employed will be undertaken here.

Monitoring frequencies for the various parameters are adequate. Currently, fluoride residual testing in done twice per day. The program for routine disposal of laboratory wastes appears adequate by autoclaving the material and then disposing liquids in the sink and all other material in the trash.

Staff does not test for nor speciate algae or taste and odor. A Quebec colony counter is available for lab staff to use. Staff should be familiar with algae counting and speciation and should perform such routinely.

Treatment Optimization:

It is important to optimize treatment practices to minimize the potential for contamination from microorganisms such as Cryptosporidium and Giardia or other unforeseen contaminants. Appendix D contains a copy of "Recommended Practices for Treatment Optimization". This document prepared by this office in association with industry was provided to all water plants in May of 1995. It is recommended that these practices be studied to determine ways in which treatment may be further optimized. While the details of the document will not be reiterated here, certain practices have proven useful for other water plants. It is hoped that as many optimization practices as possible will be implemented.

Reliability: There are two emergency risers located on the raw water intake line for situations when the crib is unavailable. The riser closest to the intake crib is inspected every other year as part of the biennial crib and intake line inspection. The second riser was located in 2006 and inspected. Bolts on the second riser were replaced.

A generator has recently been installed to provide auxiliary power to the entire water plant during a power outage. It has been exercised and tested and is working satisfactorily. Generator is run once a month. Fuel is refreshed annually.

There is one metered emergency distribution interconnection with the City of St. Joseph water system. This interconnection can help during emergency pressure problems or to aid during a fire. The interconnection should be defined hydraulically to determine available flow rate. Several connections to the Benton Township distribution exist, but at the time of this survey an emergency interconnection agreement was not in place. The interconnection with St. Joseph Township is proposed to be metered.

At the time of the survey, all controls were working. All adjustments to the chlorine, alum, fluorosilicic acid are made manually by plant operators. Filter backwash is initiated at the filter control console by a plant operator.

Most of the controls, switch gear and breakers are located on the 2nd floor and are not subject to flooding. There is a sump in the basement and a drain through the ceiling in the first floor which leads to surface water. However, certain equipment located in the lower level (all the pumps) may be subject to flooding in the event of a catastrophic pipe/pump failure where if the sump is not capable of removing all the water to prevent flooding.

The last reliability study was completed in 2008 and will need to be updated in 2013 according to Part 12 of Act 399. A 5 and 20 year capital improvement plan (CIP) must be included in the next Study. A hydraulic analysis of the distribution system must also be included in the study to prioritize distribution system projects and gather information to update the water system general plan (distribution system map).

Operators: Although the water plant currently meets regulations and DEQ policy regarding operator certification, we recommend another F-1 operator be provided for to provide additional oversight of plant operations.

Report Summary:
The following recommendations are intended to be a concise summary of the items contained in the previous sections. Page references are in parentheses. Since some improvements are a higher priority or will take longer to complete than others, we have divided the recommendations in two categories to indicate immediate and long term implementation schedules.

Recommendations - Immediate or ASAP Implementations (<12 months)

1. Repair and ensure fluoride feed system is working consistently and adequately.
2. Repair filter spray wash control valves.
3. Inspect and clean intake. Be sure GPS readings are available for the emergency risers and are on the ERP.
4. Update the ERP.

5. Clean backwash lagoon sludge.

Recommendations - Long term implementation (>12 months)

1. Hire or promote within another F1 plant operator (recommended)
2. Evaluate rapid mix G value in the new mixing basin.
3. Start inspecting the finished water reservoir comprehensively on a regular basis, say every five years.

DISTRIBUTION SYSTEM

GENERAL

Primary Contact: Stewart Beach
Title: Utilities Director
Telephone: 269 927 8471
Cell Phone: 269 363 0575
Pager:
Fax: 269 927 8469
e-mail: sbeach@cityofbentonharbormi.gov
Mailing Address:
200 East Wall Street
Benton Harbor, MI 49023-0648

Copy To: Darwin Watson
Title: City Manager
Telephone: 269 927 8400 ext. 9
Cell Phone:
Pager:
Fax: 269 927 0304
e-mail: dwatson@cityofbentonharbormi.gov
Mailing Address:
200 East Wall Street
Benton Harbor, MI 49023-0648

Population: 10,038 Year: 2010 Basis: census

Water Purchased From/Supplier: NO WSSN of Supplier: NA

Operator Certification

Distribution Classification: S-2

Operator-in-Charge:	Stewart Beach	Cert: S-1, F-1	Oper ID: 2273
Designated Back-Up:	Demetrius Meeks, DPW Foreman	Cert: S-4	Oper ID: 9658
Other Operators:	Darwin Watson	Cert. S-2 / F-4 exp	Oper ID: 4710
	Denny Edwards	Cert. S-4 / F-4	Oper ID: 4753
	Kaye Jenkins	Cert. S-4 (exp)	Oper ID: 5236
	Cleveland Smalligan	Cert. none	Oper ID: none
	Dennis Hudson	Cert. none	Oper ID: none
	Raymond Hudson	Cert. none	Oper ID: none
	Henry Clayton	Cert. none	Oper ID: none
	Richard Woods	Cert. none	Oper ID: 18606
	Eddie Ellis	Cert. none	Oper. ID: none
	Eddie Davis	Cert. none	Oper ID: 13771
	Steve Forbear	Cert. none	Oper. ID. None
	Patrick Patterson	Cert. none	Oper. ID. None
	Sabrina Spain	Cert. none	Oper. ID. None

SANITARY SURVEY EVALUATION FORM

Ownership
Ownership: City – council / manager

Consent Agreement: NA

Escrow Account: NA

Annual Fee: active
Comments: Darwin Watson, City Manager

STORAGE

Construction, Controls & Maintenance

	Location: Britain Street	Location: Water Treatment Plant
Volume	650,000 gal	2,000,000 gal
Type	steel elevated	concrete ground
O.F. Elevation	768.5	above grade
Date Constructed	1938	c 1950
Date Inspected	2003	'04, '08
Date Painted Inside	1991	NA
NSF Std 61 (Y/N)	yes	NA
Date Painted Outside	1991	NA
Cathodic Protection	yes	NA
Tank Isolation Valve	yes	yes
Tank Drain (Hydrant)	yes	none
Altitude Valve	yes	no
Mud Valve	yes	
High Alarm	yes	yes
Low Alarm	yes	yes
Chart recorder	SCADA	SCADA
Telemetering System	SCADA	SCADA
Vents Screened	¼" holes	yes
Overflow Screened	unknown	unknown
Hatches Locked	unknown	yes
Site Fenced/Locked	yes	yes
Capacity		
Usable Storage:	650,000	2,000,000

Total Usable Storage: 2,650,000 gal 2.65 MG

Storage/Max Day: ~ 40% Storage/Avg. Day: ~ 67%

Storage Comments: Benton Township recently completed water plant and transmission main construction, and the Township is no longer a City customer. This separation has reduced the City customer population by approximately 30 percent. Consequently the Euclid standpipe and M-139 ground reservoir are no longer available for routine use by the City. The ground finished water storage tank at the treatment plant is reliable and not needed for chlorine contact treatment. (see appendix C). Additional elevated storage is recommended. In the absence of additional elevated storage, an emergency agreement with Benton Charter Township and a hydraulic definition of the St. Joseph interconnect should be obtained to help provide reliable fire protection to the City and the remaining customers.

DISTRIBUTION

Interconnections with Other Supplies

Name of Principle Supplier(s)/Wholesaler(s): NA

List WSSN number(s): NA

No. of Emergency Connections: 1 (not including Benton Charter Township)

Location	Main Size	Est.Cap.	Metered?	Status (Regular/Emergency)	Connection w/WSSN
M-63	12-inch	unknown	yes	emergency	6310
Main St.	12-inch	unknown	no	out of order	6310
Woodruff & Empire	12-inch		yes	Proposed emergency	6310 & 3726

If emergency, are valves exercised annually? yes

Flushed? no

Comments on Interconnections with Other Supplies: The City is not planning to repair Main Street emergency interconnection. The main was dislodged in a shipping accident under the river and repairs are costly.

The St. Joseph distribution system is on a higher hydraulic grade line than the City, and the City has benefitted from the connection in the recent past. A two-way meter installed in a walk-in chamber along the M63 right-of-way embankment provides the only interconnect at this time. Plans made and a permit obtained to connect the Benton Harbor system with St. Joseph at Empire and Woodruff Streets.

Interconnections with Benton Charter Township exist, but an emergency service agreement does not currently exist between the City and the Township. Without an agreement in place to open the normally closed valves, capacity between the water systems cannot be considered as available.

Distribution Piping

Identify distribution piping materials - estimate percentages:

Cast Iron	80%
Ductile Iron	20%
PVC	0%
AC	0%
HDPE	0%
Galvanized	<1%
Concrete	0%
Lead	<1%

Estimated percent of piping with coal tar lining 10%

Identify distribution pipe sizes - estimate percentages:

2"	0.7%
4"	24.8%
6"	36.1%
8"	9.3%
10"	3.2%
12"	13.8%
16"	2.9%
18"	0.4%
20"	8.9%

Main amounts are per Abonmarche March 2008 DWRF project plan. 350,503 total feet.

Distribution system dates back prior to State program of 1913 (c1890). Earliest state record on file is dated 1914. Water main amounts should be updated with a new general plan as they are revealed. City should plan for elimination of all undersized, galvanized, and lead main.

Pump Stations

Location: Grand Blvd

Function: Boost Pressure to Benton Township – NO LONGER IN USE

Pump Number	1 lag	2 lead
Year Installed	1968	1968
Type	split case	horizontal centrifugal
Permit Capacity	1000 gpm	1000 gpm
Permit TDH		
Current Capacity	960 gpm	960 gpm
Basis	2000 rebuild	2000 rebuild
Current TDH		
HP	60	60
Last Complete Inspection	2011	2011
Last Efficiency Test	2011	2011

Total Pump Capacity	2000 gpm
Firm Pump Capacity	1000 gpm
Auxiliary Power Capacity	2000 gpm

Comment on Pump Stations: Motors have Variable Frequency Drives (VFDs) installed. Booster station is on standby with the separation of the pressure district in the Township. The City has no plans to utilize this station in the future. Currently used for record storage.

Auxiliary Power

Power Type:	electrical generator
Power Rating (kWh):	
Fuel Type:	natural gas
Starting Frequency:	
Load Testing Frequency:	

Max Day Demand @ this location	mgd
Avg Day Demand @ this location	mgd
Firm Pump Capacity/Max Day	%
Aux. Power Capacity/Avg Day	%

Comment on Auxiliary Power: A new generator was installed with the recent DWRF project to replace the old 1968 generator. The booster station is no longer in use.

Operational Concerns & Maintenance

Are there areas where water main breaks are frequent? no

If yes, identify locations: NA

Are there areas where aesthetic water quality complaints are frequent? no

Do you receive complaints alleging illness due to the water? no

Is a procedure in place to respond to and track these complaints? yes

Are there areas where customers complain of low pressure? no

If yes, identify locations:

Comments on Main Breaks, Aesthetic Problems, Complaints: Early 20th Century 2-inch lead main on McAlister Road serves one block and leaks at isolation valve. City needs to replace the rest of small diameter and lead main. All complaints regarding illness from drinking water should be reported to the DEQ.

Are there areas where fire flows cannot be maintained? Yes.

If yes, list locations: Robbins Street, Thresher west of McCord.

Last ISO report date? 9/18/1990 Rating: 5

Which, if any, of the above listed areas has the supply prioritized for main replacement, upgrading, or looping? Also, if a definite schedule for capital improvement has been established, list the proposed completion date:

Location:	Estimated Completion Date:
McAlister – replace lead main	unknown

Hydrant replacement program currently out for bid, targets one hydrant in each area.

Comment on Capital Improvements, ISO Rating: Fire flows tested frequently. City intends to pursue project to replace 4-inch main simultaneously with sewer upgrades. Cherry Street and Summit Street are both slated for replacement, upsizing, and looping this year.

Hydrants

Number of Hydrants: ~ 450

Number without Auxiliary Shut-Off Valves: 30

Number that are Self-Draining: 99%

Number of Inoperable Hydrants: 7%

Frequency of Hydrant inspection: annually

Are there areas where additional hydrants are needed? no

If yes, list locations:

Hydrant location system: maps Accurate? yes

Are hydrants color coded for capacity? yes*

Has this information been provided to the fire department? yes

Frequency and seasons of hydrant flushing: annually

Purpose of flushing: maintenance

Is the public notified prior to flushing? no

Does flushing follow a specific format? yes

Is the volume of water used during flushing estimated? no

Is a record maintained of hydrant activities? no

Comments on Hydrants:
Hydrant records should include: hydrant number, location of the hydrant, type of hydrant, size of barrel, size of bottom valve, size of lead, direction of turn, operable or inoperable, auxiliary valve type and size, weep holes plugged or unplugged, condition of hydrant (caps, chains, valve operation, operating nut, leakage & etc.), color coded capacity, flow data (gpm & psi), flushing dates, inspection dates.

Color coding does not follow AWWA standards: *orange - marginal; black - does not work; red - one part not working; green - good flow. Hydrant records are lacking and the numbers above are the best guess. A full hydrant assessment should be done as soon as possible.

Valves

Number of Valves: 2,500

Are there areas where additional valves are needed? yes

If yes, list locations: Lake Street area – from Empire to Main Street
Lake Street area – from Colfax to Pipestone

Valve location system: master map & books Accurate? questionable

Valve Turning Frequencies: none

Primary: none

Others: none

Records Maintained? NO

Comments on Valves: The City distribution crew does not have turn valves regularly or have a program for such. Several valves (~25) were found closed without record during the recent Township / City separation transmission project. Similar problems were found during recent winter frost penetration. Closed valves can result in increased power costs and pump wear and tear. Valve records should include: valve number, GPS location of valve (with witness points), type of valve, size of valve, normal operating status (open or closed), condition of valve (operable or inoperable), direction of turn, number of turns, and dates of operation.

Customer Service Information

Number of service connections: ~ 3476

Number of metered service connections: 98%

City Hall, Police & Fire Station, several Parks unmetered. More unmetered services are being discovered due to poor record keeping.

Identify service line materials and estimate percentages:

Copper: 30 %

PVC/PE/HDPE: <1%

Galvanized: 70 %

Lead: ? % **lead services exist but poor records cannot verify amounts**

Ownership of Service (City/Customer)

From Corp Stop to Curb Stop:	City
From Curb Stop to Property Line:	City
From Property Line to Meter:	customer
Meter:	City

Customer Meters

Types of meters Used: Sensus

Meter Testing/Maintenance Program: unknown

Criteria for Changeout: FAILURE

Number or Percent Changeout per Year: ~ 100 (2-3%)

Master Meter Locations: WTP

Calibration of Master Meters: quarterly

% Large Users - List

Whirlpool 175,000 gallons per day

Comment on Metering System: Compound meters are Trident and Rockwell. Several customers have non-working, or old and slipping meters according to staff. Slipping meters may be a large portion of lost water. Water theft and tampering (by-passing) is common. Many water bills are in arrears. Poor customer metering practice in the past has hurt the system. City currently has grant to replace all meters in the system to radio read. Progress is about 10% as of June 1, 2015.

Water Rates

What is your current rate schedule? $3.85/100 ft³ (or $5.08/1,000 gallons)

Are current rates adequate to support O&M and CIPS? no

When was the last time the rates were adjusted? 2013

Has a water rate study been performed? 2012 – Abonmarche

Is there a meter charge or ready to serve charge? Yes - 5/8-inch meter $9.03

Is a copy of the rate schedule and ordinance available? yes

Comment on Water Rates: Several rate increases have occurred over the past few years. The City has a meter rental policy for contractor hydrant use, but does not use it consistantly. Proper operation and maintenance cannot be performed without adequate revenue.

PROGRAM COMPLIANCE

Cross Connection Programs

Ordinance No. 44.38 Date: 6/29/1977

Approved Program? yes Date:

Staff Assigned to Program, (No., Dept and/or who) DPW crew

Is Annual Cross Connection report required (Y/N)? yes

Was previous year's annual report acceptable (Y/N)?

Inspection Status: overdue

Device Testing Frequency: overdue

Recordkeeping Adequate? no

Comment on Cross Connection Program: Hydro Designs was under contract for cross connection administration in recent years. The City intends on rehiring Hydro Designs to perform the inspections. Most city-made inspections are made in response to water complaints or high bills.

City staff recently discovered two abandoned sanitary sewer flushing manholes.

SANITARY SURVEY EVALUATION FORM

Monthly Operation Reports

Are Monthly Operation Reports required (Y/N)? yes

Are previous year's reports acceptable (Y/N)? yes

If no, describe problems:

Comment on MOR's: Water usage unrelated to normal demands, such as construction, fire fighting, leaks, tank filling, flushing, should be dated on MOR.

Consumer Confidence Reports

Is the annual CCR required? (Y/N) yes

Was the previous year's acceptable? (Y/N) Yes

Was the previous year's certification form received? Yes Timely? Yes

Comments on CCR:

Emergency Response Plan

Date of Most Recent Plan: 3/1/2005 Acceptable? yes

Filed Where? Water Plant

Comments on ERP: EPA Vulnerability Study and Emergency Response Plan are available.

General Plan

Date of Most Recent Plan: 2008 Acceptable? NO

Filed Where?

Comments on General Plan: Recently updated map as part of DWRF project planning. Hydraulic grade line, flow capacity from interconnect(s), and computer modeling still required. 2008 has several inaccuracies. New requirements due in 2016.

Reliability Study

Date of Most Recent Study: 3/27/2008 Acceptable? yes

Filed Where?

Comment on Reliability Study: Next Reliability Study due in 2016.

SANITARY SURVEY EVALUATION FORM

Permits

Applies for and obtains permits prior to construction (Y/N): yes

Reviews plans prior to submittal to DEQ (Y/N): yes

Standard specifications on file at CWS (Y/N): yes

Date of Last Master Plan: unknown

Follows master plan for any construction (Y/N):

Actually follows plans as permitted (Y/N): yes

Develops as-built plans (Y/N): yes

Updates general plans (Y/N): Currently updating portions of system maps

Bacteriological

Date of Approved Site Sampling Plan:

Name of Certified Lab Used: City of Benton Harbor Water Treatment Plant 0600

MCL, Monitoring or Reporting Violation(s)? (Y/N) No

Number & Type of Violations in past 12 months: none

Public Notice Issued according to regulations? (Y/N) NA

Bacti Plan Comments: Bacteriological samples are being collected in accordance with the approved Sampling Site Plan (Plan).

Chemical

Date of Monitoring Schedule: 2015

If nitrite detect, what is concentration? 1.5 mg/l

Detects for metals > 50% of MCL? (Y/N) none

Metals (list):

Detects for VOCs (Y/N) only DBPs within range of disinfection

Detects for SOCs (Y/N) none

Date of Disinfection Byproduct Monitoring Plan: Stage I DBP 12/4/01 Stage II DBP 4/19/2010

DBP Sampling Done according to plan? (Y/N) yes. Plan(s) should be revised to reflect recent loss of customer base.

Lead and Copper Monitoring

No. of Samples Required: 30

☐ Semi Annual ☐ Annual ☒ Triennial

Exceedance of lead or copper action level (Y/N) no

If yes, was public education issued (Y/N) NA

Next Monitoring Period: summer 2015

Corrosion Control Program, if applicable: NA

Lead service line replacement status, if applicable: NA

Chemical Monitoring Comments: The lead/copper sample locations must be chosen to reflect the reduction of the system service area. New locations may need to be added to make up for lost locations in the former customer supply service areas.

Radiological Monitoring

Samples being collected in accordance with the schedule? (Y/N) yes

Alpha, beta, radium, uranium	yes
Radon	NA
Tritium	NA

Detects for Rads > 50% of MCL? (Y/N) no

If yes, list:

Distribution System Comments: The distribution system is keeping the City from a "satisfactory" rating now that the treatment plant upgrades are complete. A lack of valve turning and records, unaccounted for pumped water amounts, lack of hydrant records, lack of updated completed general plan and overall records, and small undersized main amounts, are needing dire attention. The cross connection program was given to a private contractor in the past because the City was not performing this task, and is now considering doing the inspections in-house. Additional elevated storage capacity should be considered now that the Township storage tanks are no longer routinely available. An emergency service agreement should be entered with Benton Charter Township to ensure distribution reliability.

Report Summary:

The following recommendations are intended to be a concise summary of the items contained in the previous sections. Page references are in parentheses. Since some improvements are a higher priority or will take longer to complete than others, we have divided the recommendations in two categories to indicate immediate and long term implementation schedules.

RECOMMENDATIONS - IMMEDIATE OR ASAP IMPLEMENTATION (<12 MONTHS)

1. Inventory, map, and turn all valves.
2. Complete general plan, including hydraulic grade line by January 1, 2016.

3. Develop emergency use agreements with nearby water supplies.
4. Continue comprehensive cross connection inspections according to program.
5. Find and eliminate all sanitary sewer flushing manholes.
6. Replace meters with the SAW grant. (10% to date)
7. Repair all visible leaks.

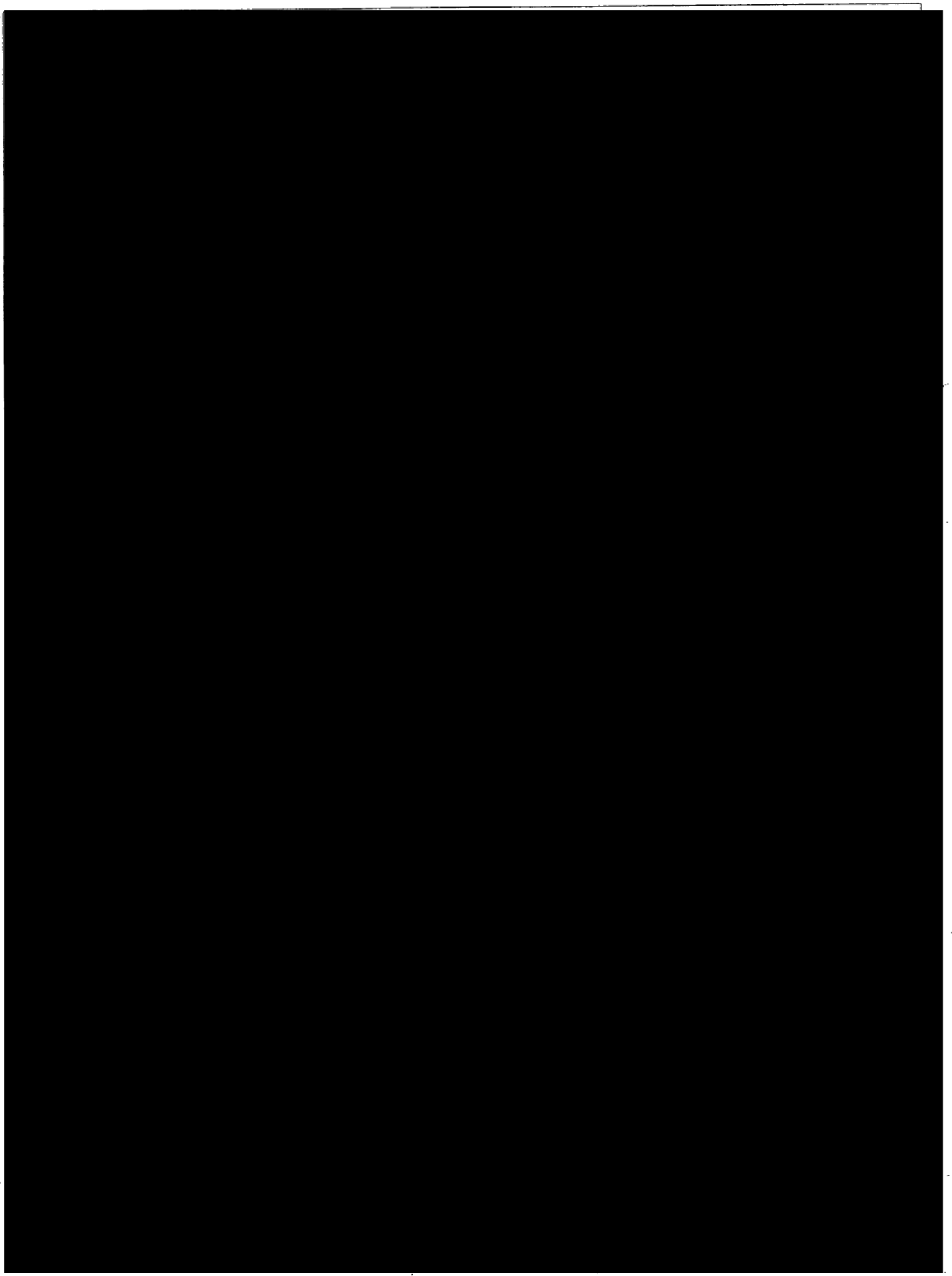
RECOMMENDATIONS - LONG TERM IMPLEMENTATION (>12 MONTHS)

1. Repair or replace needed valves.
2. Repair or replace needed hydrants.
3. Plan and start a comprehensive main replacement program for undersized main.
4. Plan for construction of new elevated storage tank.
5. Evaluate recommendations in the 2013 Tower inspection report – Ira Gabin of Dixon Engineering.
6. Reduce lost water amounts; perform a leak survey, meter City-owned accounts, reassess.

APPENDICES

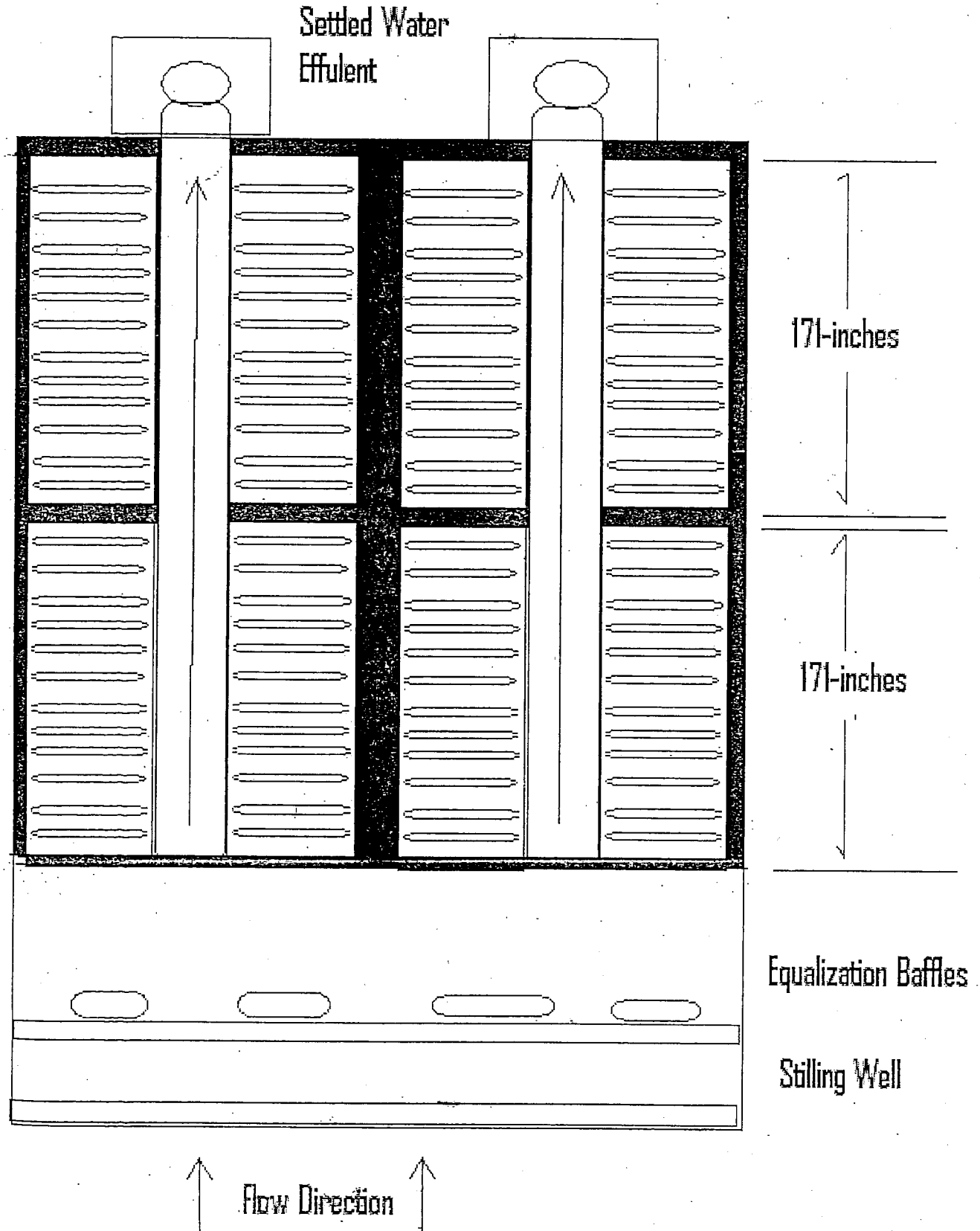
APPENDIX A

Plant Flow Diagram



Benton Harbor Water Treatment Plant. Plate Settler Chamber
4 Units. Overflow weir of 171-inches each
2 Sets of Treatment Chains North and South.

8 x 171-inches = 1368 total inches
= 114 feet.



APPENDIX B

2015 Monitoring Schedule
Chemical Sample Results
Trihalomethane (TTHM) Averages
Haloacetic Acid (HAA5) Averages
Total Organic Carbon Removal Averages

2015 Monitoring Schedule

BENTON HARBOR WSSN: 00600

Collect samples early in the monitoring period. This schedule reflects your expected routine monitoring and is subject to change. To receive credit for monitoring, include the **WSSN, Site Code**, and **County** on your request for analysis form. Collect Bacteriological and Automated Partial Chemistry samples close to the shipping time and send overnight delivery. Send all sample results to your Department of Environmental Quality (DEQ) district office unless you use the DEQ laboratory. Test codes, sample units, and costs are listed to help you complete the DEQ laboratory form. Prices are subject to change without notice. The DEQ laboratory is closed on state holidays.

Location: Treatment Plant Tap

Collect these samples at the entry point to the distribution system (after treatment, if applicable.)

Sample Type	# Samples/ Frequency	Collect Before	Site Code	Fee	Unit Number	Test Code
Automated Partial Chemistry	This DEQ lab scan includes nitrate, nitrite, fluoride, and sodium whose monitoring frequency requirements differ from one another. Before requesting analyses from a laboratory other than the DEQ laboratory, check with your DEQ district staff for the specific monitoring requirements.					
	1/12 months	09/30/2015	TP001	$18.00	32	R
Volatile Organic Compounds	1/12 months	09/30/2015	TP001	$100.00	36VO	CXVO
Complete Metals	1/108 months	09/30/2021	TP001	$102.00	36ME	CMET2
Cyanide	1/12 months	09/30/2015	TP001	$25.00	36CNa	CCN
SOC – Pesticides	1/36 months	09/30/2015	TP001	$125.00	36PT	CXPT
SOC – Herbicides	1/36 months	09/30/2015	TP001	$120.00	36HB	CXHB
SOC – Carbamates	1/36 months	09/30/2015	TP001	$120.00	36LP	CXLP
Gross Alpha (Radiological)	1/72 months	09/30/2020	TP001	Not performed at the DEQ Laboratory. A list of certified labs is at www.michigan.gov/DEQ. Select Water, Drinking Water, Community Water Supply, then Certified Labs under Programs and Activities.		
Radium 226 & Radium 228	1/108 months	09/30/2023	TP001			
Total Organic Carbon (TOC)	Pair/Quarterly	Quarterly	TP001	$35.00	36TO	CTOC
	Monitor for TOC in the source water before any treatment at the same time as monitoring for TOC in the treated water. These samples (source water and treated water) are referred to as "paired samples." Collect the treated water sample not later than the point of combined filter effluent turbidity monitoring and representative of treated water.					

Location: Second Quarter SOCs

Collect these samples at the entry point to the distribution system (after treatment, if applicable.)

Sample Type	# Samples/ Frequency	Collect Before	Site Code	Fee	Unit Number	Test Code
SOC – Pesticides	1/36 months	06/30/2015	TP001	$125.00	36PT	CXPT
SOC – Herbicides	1/36 months	06/30/2015	TP001	$120.00	36HB	CXHB
SOC – Carbamates	1/36 months	06/30/2015	TP001	$120.00	36LP	CXLP

Location: Distribution System

Sample Type	Collect Samples According to the ...	# Samples/ Frequency	Collect	Site Code	Fee	Unit Number	Test Code
Bacteriological – coliforms	TCR Sampling Site Plan	10/Monthly	Monthly	DIST	$16.00	30	BPTC
Chlorine Residual	DBP Monitoring Plan	Measure the residual disinfectant level at the same point and at the same time as the bacteriological sample and report the average to the DEQ.					
Lead Copper for Corrosion Control	Lead and Copper Sampling Pool	30/36 months	Between 06/01 and 9/30/2015	DIST	$26.00	36CC	CCUB
Total Trihalomethanes	DBP Monitoring Plan	2/3 months	During February, May, August and November 2015	See DBP Monitoring Plan	$65.00	36VO	CXTM
Haloacetic Acids		2/3 months	During February, May, August and November 2015	See DBP Monitoring Plan	$130.00	36HA	CXHA

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER LABORATORY
USEPA Region V Drinking Water Cert. No. MI00003
P.O. Box 30270
Lansing, MI 48909
TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LF54105

RECEIVED
MICH. DEPT. OF NATURAL RESOURCES AND ENVIRONMENT
FEB 23 2015
ENVIRONMENTAL RESOURCE MANAGEMENT DIVISION
KALAMAZOO DISTRICT OFFICE

Official Laboratory Report

Report To: KYLE TRYAN
1181 N SHORE DR
BENTON HARBOR MI 49022

System Name/Owner:	BENTON CHARTER TWP	WSSN/Pool ID:	0605
Collection Address:	1181 N SHORE DR,BENTON HARBOR	Source:	TYPE I
Collected By:	KYLE TRYAN	Site Code:	TP001
Township/Well#/Section:	BENTON//	Collector:	Public Water Supply Operator
County:	Berrien	Date Collected:	02/09/2015 10:20
Sample Point:	PLANT TAP - LAB SINK	Date Received:	02/10/2015 12:52
Water System:	Treated Public Distribution System	Purpose:	Routine Monitoring

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Antimony	Not detected	02/11/2015	0.0006	0.006	EPA 200.8	7440-36-0
Arsenic	Not detected	02/11/2015	0.002	0.010	EPA 200.8	7440-38-2
Barium	0.03	02/11/2015	0.01	2	EPA 200.8	7440-39-3
Beryllium	Not detected	02/11/2015	0.0004	0.004	EPA 200.8	7440-41-7
Cadmium	Not detected	02/11/2015	0.0003	0.005	EPA 200.8	7440-43-9
Chromium	Not detected	02/11/2015	0.01	0.1	EPA 200.8	7440-47-3
Cyanide-Available	Not Detected	02/13/2015	0.02	0.2	OIA-1677	57-12-5
Lead	Not detected	02/11/2015	0.001	0.015	EPA 200.8	7439-92-1
Mercury	Not Detected	02/11/2015	0.0001	0.002	EPA 200.8	7439-97-6
Nickel	Not detected	02/11/2015	0.01	0.1	EPA 200.8	7440-02-0
Selenium	Not detected	02/11/2015	0.001	0.05	EPA 200.8	7782-49-2
Thallium	Not detected	02/11/2015	0.0002	0.002	EPA 200.8	7440-28-0
Carbamates by HPLC CXCP						
3 Hydroxycarbofuran	Not Detected	02/19/2015	0.001		EPA 531.2	16655-82-6
Aldicarb	Not Detected	02/19/2015	0.0005		EPA 531.2	116-06-3
Aldicarb sulfone	Not Detected	02/19/2015	0.0005		EPA 531.2	1646-88-4
Aldicarb sulfoxide	Not Detected	02/19/2015	0.0005		EPA 531.2	1646-87-3
Carbaryl	Not Detected	02/19/2015	0.001		EPA 531.2	63-25-2
Carbofuran	Not Detected	02/19/2015	0.0005	0.04	EPA 531.2	1563-66-2
Methiocarb	Not Detected	02/19/2015	0.001		EPA 531.2	2032-65-7
Methomyl	Not Detected	02/19/2015	0.001		EPA 531.2	16752-77-5
Oxamyl	Not Detected	02/19/2015	0.001	0.2	EPA 531.2	23135-22-0
Propoxur	Not Detected	02/19/2015	0.001		EPA 531.2	114-26-1

CAS# : Chemical Abstract Service Registry Number
MCL : Maximum Contaminant Level
AL : Action Level
RL : Reporting Limit

mg/L : milligrams / Liter (ppm)
ppm : parts per million
MPN : Most Probable Number
CFU : Colony Forming Unit

Laboratory Contacts
Drinking Water Unit Mgr: Julia Pieper
Systems Mgmt. Unit Mgr: George Krisztian

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER LABORATORY
USEPA Region V Drinking Water Cert. No. MI00003
P.O. Box 30270
Lansing, MI 48909
TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LF54105

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Chlorinated Acid Herbicides CXHB						
2,4,5-T	Not Detected	02/11/2015	0.002		EPA 515.4	93-76-5
2,4,5-TP (silvex)	Not Detected	02/11/2015	0.0002	0.05	EPA 515.4	93-72-1
2,4-D	Not Detected	02/11/2015	0.001	0.07	EPA 515.4	94-75-7
Acifluorfen	Not Detected	02/11/2015	0.004		EPA 515.4	50594-66-6
Bentazon	Not Detected	02/11/2015	0.002		EPA 515.4	25057-89-0
Dicamba	Not Detected	02/11/2015	0.002		EPA 515.4	1918-00-9
Dinoseb	Not Detected	02/11/2015	0.0002	0.007	EPA 515.4	88-85-7
Pentachlorophenol	Not Detected	02/11/2015	0.00004	0.001	EPA 515.4	87-86-5
Picloram	Not Detected	02/11/2015	0.001	0.5	EPA 515.4	1918-02-1
Total DCPA degradates, mono- and di-acid	Not Detected	02/11/2015	0.001		EPA 515.4	1861-32-1

Quality control results for acifluorfen were outside allowed limits due to matrix interferences.

Pesticides Analysis by GC/MS CXPT						
4,4'-DDD	Not Detected	02/17/2015	0.001		EPA 525.2	72-54-8
4,4'-DDE	Not Detected	02/17/2015	0.001		EPA 525.2	72-55-9
4,4'-DDT	Not Detected	02/17/2015	0.0005		EPA 525.2	50-29-3
Acetochlor	Not Detected	02/17/2015	0.001		EPA 525.2	34256-82-1
Alachlor	Not Detected	02/17/2015	0.0002	0.002	EPA 525.2	15972-60-8
Aldrin	Not Detected	02/17/2015	0.0004		EPA 525.2	309-00-2
alpha-Chlordane	Not Detected	02/17/2015	0.0002	0.002	EPA 525.2	5103-71-9
Atrazine	Not Detected	02/17/2015	0.0002	0.003	EPA 525.2	1912-24-9
Dieldrin	Not Detected	02/17/2015	0.0005		EPA 525.2	60-57-1
Endrin	Not Detected	02/17/2015	0.0001	0.002	EPA 525.2	72-20-8
Endrin aldehyde	Not Detected	02/17/2015	0.001		EPA 525.2	7421-93-4
gamma-Chlordane	Not Detected	02/17/2015	0.0002	0.002	EPA 525.2	5103-74-2
Heptachlor	Not Detected	02/17/2015	0.0002	0.0004	EPA 525.2	76-44-8
Heptachlor epoxide	Not Detected	02/17/2015	0.0001	0.0002	EPA 525.2	1024-57-3
Hexachlorobenzene	Not Detected	02/17/2015	0.0001	0.001	EPA 525.2	118-74-1
Hexachlorocyclohexane (alpha-BHC)	Not Detected	02/17/2015	0.001		EPA 525.2	319-84-6
Hexachlorocyclohexane (beta-BHC)	Not Detected	02/17/2015	0.001		EPA 525.2	319-85-7
Hexachlorocyclohexane (delta-BHC)	Not Detected	02/17/2015	0.001		EPA 525.2	319-86-8
Hexachlorocyclopentadiene	Not Detected	02/17/2015	0.0005	0.05	EPA 525.2	77-47-4
Lindane (gamma-BHC)	Not Detected	02/17/2015	0.0001	0.0002	EPA 525.2	58-89-9
Methoxychlor	Not Detected	02/17/2015	0.0001	0.04	EPA 525.2	72-43-5
Metolachlor	Not Detected	02/17/2015	0.001		EPA 525.2	51218-45-2

CAS# : Chemical Abstract Service Registry Number
MCL : Maximum Contaminant Level
AL : Action Level
RL : Reporting Limit

mg/L : milligrams / Liter (ppm)
ppm : parts per million
MPN : Most Probable Number
CFU : Colony Forming Unit

Laboratory Contacts
Drinking Water Unit Mgr: Julia Pieper
Systems Mgmt. Unit Mgr: George Krisztian

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER LABORATORY
USEPA Region V Drinking Water Cert. No. MI00003
P.O. Box 30270
Lansing, MI 48909
TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LF54105

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Pesticides Analysis by GC/MS						
Metribuzin	Not Detected	02/17/2015	0.001		EPA 525.2	21087-64-9
Molinate	Not Detected	02/17/2015	0.0005		EPA 525.2	2212-67-1
PCB (aroclor 1016)	Not Detected	02/17/2015	0.0001	0.0005	EPA 525.2	12674-11-2
PCB (aroclor 1221)	Not Detected	02/17/2015	0.0001	0.0005	EPA 525.2	11104-28-2
PCB (aroclor 1232)	Not Detected	02/17/2015	0.0001	0.0005	EPA 525.2	11141-16-5
PCB (aroclor 1242)	Not Detected	02/17/2015	0.0001	0.0005	EPA 525.2	53469-21-9
PCB (aroclor 1248)	Not Detected	02/17/2015	0.0001	0.0005	EPA 525.2	12672-29-6
PCB (aroclor 1254)	Not Detected	02/17/2015	0.0001	0.0005	EPA 525.2	11097-69-1
PCB (aroclor 1260)	Not Detected	02/17/2015	0.0001	0.0005	EPA 525.2	11096-82-5
Polybrominated biphenyls	Not Detected	02/17/2015	0.0001		EPA 525.2	59536-65-1
Simazine	Not Detected	02/17/2015	0.0002	0.004	EPA 525.2	122-34-9
Toxaphene	Not Detected	02/17/2015	0.001	0.003	EPA 525.2	8001-35-2

Quality control results for molinate were outside allowed limits due to matrix interferences.

The analyses performed by the MDEQ Drinking Water Laboratory were conducted using methods approved by the U .S. Environmental Protection Agency in accordance with the Safe Drinking Water Act, 40 CFR parts 141-143, and other regulatory agencies as appropriate.

Your local health department has detailed information about the quality of drinking water in your area. If you have concerns about the health risks related to the test results of your sample, please contact the Environmental Health Section through the address and telephone number listed below:

Berrien County
2106 South M-139
Benton Harbor, MI 49022
269 927-5623

CAS# : Chemical Abstract Service Registry Number
MCL : Maximum Contaminant Level
AL : Action Level
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mg/L : milligrams / Liter (ppm)
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Systems Mgmt. Unit Mgr: George Krisztian

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER LABORATORY

USEPA Region V Drinking Water Cert. No. MI00003
P.O. Box 30270
Lansing, MI 48909
TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LF54308

RECEIVED
MICH. DEPT. OF NATURAL RESOURCES AND ENVIRONMENT
FEB 23 2015
ENVIRONMENTAL RESOURCE MANAGEMENT DIVISION
KALAMAZOO DISTRICT OFFICE

Official Laboratory Report

Report To: KYLE TRYAN
1181 N SHORE DR
BENTON HARBOR MI 49022

System Name/Owner:	BENTON CHARTER TOWNSHIP	WSSN/Pool ID:	0605
Collection Address:	1181 N SHORE DR,BENTON HARBOR	Source:	TYPE I
Collected By:	KYLE TRYAN	Site Code:	TP001
Township/Well#/Section:	BENTON//	Collector:	Public Water Supply Operator
County:	Berrien	Date Collected:	02/10/2015 08:40
Sample Point:	PLANT TAP LAB SINK	Date Received:	02/11/2015 11:13
Water System:	Treated Public Distribution System	Purpose:	Routine Monitoring

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Chloride	17	02/11/2015	4		SM 4500-Cl E	7647-14-5
Fluoride	0.84	02/11/2015	0.1	4.0	SM 4500 FC	16984-48-8
Hardness as CaCO3	174	02/11/2015	20		SM 2340 C	HARD-00-C
Iron (automated)	Not detected	02/11/2015	0.1		SM 3500 FeB	7439-89-6
Nitrate as N	0.8	02/11/2015	0.4	10	10-107-04-2-B	14797-55-8
Nitrite as N	Not detected	02/11/2015	0.05	1	10-107-04-2-B	14797-65-0
Sodium (automated)	10	02/11/2015	5		SM 3500 NaB	7440-23-5
Sulfate	29	02/11/2015	10		SM 4500 SO4E	14808-79-8
Volatile Organic Compounds						
1,1 Dichloroethane	Not Detected	02/13/2015	0.0005		EPA 524.2	75-34-3
1,1 Dichloroethylene	Not Detected	02/13/2015	0.0005	0.007	EPA 524.2	75-35-4
1,1 Dichloropropene	Not Detected	02/13/2015	0.0005		EPA 524.2	563-58-6
1,1,1 Trichloroethane	Not Detected	02/13/2015	0.0005	0.2	EPA 524.2	71-55-6
1,1,1,2 Tetrachloroethane	Not Detected	02/13/2015	0.0005		EPA 524.2	630-20-6
1,1,2 Trichloroethane	Not Detected	02/13/2015	0.0005	0.005	EPA 524.2	79-00-5
1,1,2,2 Tetrachloroethane	Not Detected	02/13/2015	0.0005		EPA 524.2	79-34-5
1,2 Dichlorobenzene	Not Detected	02/13/2015	0.0005	0.6	EPA 524.2	95-50-1
1,2 Dichloroethane	Not Detected	02/13/2015	0.0005	0.005	EPA 524.2	107-06-2
1,2 Dichloropropane	Not Detected	02/13/2015	0.0005	0.005	EPA 524.2	78-87-5
1,2,3 Trichlorobenzene	Not Detected	02/13/2015	0.0005		EPA 524.2	87-61-6
1,2,3 Trichloropropane	Not Detected	02/13/2015	0.0005		EPA 524.2	96-18-4
1,2,4 Trichlorobenzene	Not Detected	02/13/2015	0.0005	0.07	EPA 524.2	120-82-1
1,2,4 Trimethylbenzene	Not Detected	02/13/2015	0.0005		EPA 524.2	95-63-6

CAS# : Chemical Abstract Service Registry Number
MCL : Maximum Contaminant Level
AL : Action Level
RL : Reporting Limit

mg/L : milligrams / Liter (ppm)
ppm : parts per million
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CFU : Colony Forming Unit

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Systems Mgmt. Unit Mgr: George Krisztian

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Lansing, MI 48909
TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LF54308

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Volatile Organic Compounds						
1,3 Dichlorobenzene	Not Detected	02/13/2015	0.0005		EPA 524.2	541-73-1
1,3 Dichloropropane	Not Detected	02/13/2015	0.0005		EPA 524.2	142-28-9
1,3,5 Trimethylbenzene	Not Detected	02/13/2015	0.0005		EPA 524.2	108-67-8
1,4 Dichlorobenzene	Not Detected	02/13/2015	0.0005	0.075	EPA 524.2	106-46-7
2,2 Dichloropropane	Not Detected	02/13/2015	0.0005		EPA 524.2	594-20-7
Benzene	Not Detected	02/13/2015	0.0005	0.005	EPA 524.2	71-43-2
Bromobenzene	Not Detected	02/13/2015	0.0005		EPA 524.2	108-86-1
Bromochloromethane	Not Detected	02/13/2015	0.0005		EPA 524.2	74-97-5
Bromodichloromethane	0.0052	02/13/2015	0.0005	0.080	EPA 524.2	75-27-4
Bromoform	Not Detected	02/13/2015	0.0005	0.080	EPA 524.2	75-25-2
Bromomethane	Not Detected	02/13/2015	0.001		EPA 524.2	74-83-9
Carbon tetrachloride	Not Detected	02/13/2015	0.0005	0.005	EPA 524.2	56-23-5
Chlorobenzene	Not Detected	02/13/2015	0.0005	0.1	EPA 524.2	108-90-7
Chlorodibromomethane	0.0025	02/13/2015	0.0005	0.080	EPA 524.2	124-48-1
Chloroethane	Not Detected	02/13/2015	0.0005		EPA 524.2	75-00-3
Chloroform	0.0061	02/13/2015	0.0005	0.080	EPA 524.2	67-66-3
Chloromethane	Not Detected	02/13/2015	0.0005		EPA 524.2	74-87-3
cis-1,2 Dichloroethylene	Not Detected	02/13/2015	0.0005	0.07	EPA 524.2	156-59-2
cis-1,3 Dichloropropene	Not Detected	02/13/2015	0.0005		EPA 524.2	10061-01-5
Dibromomethane	Not Detected	02/13/2015	0.0005		EPA 524.2	74-95-3
Dichlorodifluoromethane	Not Detected	02/13/2015	0.001		EPA 524.2	75-71-8
Dichloromethane	Not Detected	02/13/2015	0.0006	0.005	EPA 524.2	75-09-2
Ethylbenzene	Not Detected	02/13/2015	0.0005	0.7	EPA 524.2	100-41-4
Fluorotrichloromethane	Not Detected	02/13/2015	0.001		EPA 524.2	75-69-4
Hexachlorobutadiene	Not Detected	02/13/2015	0.0005		EPA 524.2	87-68-3
Isopropylbenzene	Not Detected	02/13/2015	0.0005		EPA 524.2	98-82-8
m & p-Xylene	Not Detected	02/13/2015	0.0005	10	EPA 524.2	XYLMP-00-C
Methyl ethyl ketone	Not Detected	02/13/2015	0.005		EPA 524.2	78-93-3
Methyl isobutyl ketone	Not Detected	02/13/2015	0.005		EPA 524.2	108-10-1
Methyl-tert-butyl ether (MTBE)	Not Detected	02/13/2015	0.001		EPA 524.2	1634-04-4
Naphthalene	Not Detected	02/13/2015	0.0005		EPA 524.2	91-20-3
n-Butylbenzene	Not Detected	02/13/2015	0.0005		EPA 524.2	104-51-8
Nitrobenzene	Not Detected	02/13/2015			EPA 524.2	
n-Propylbenzene	Not Detected	02/13/2015	0.0005		EPA 524.2	103-65-1
o-Chlorotoluene	Not Detected	02/13/2015	0.0005		EPA 524.2	95-49-8
o-Xylene	Not Detected	02/13/2015	0.0005	10	EPA 524.2	95-47-6
p-Chlorotoluene	Not Detected	02/13/2015	0.0005		EPA 524.2	106-43-4
p-Isopropyltoluene	Not Detected	02/13/2015	0.0005		EPA 524.2	99-87-6
sec-Butylbenzene	Not Detected	02/13/2015	0.0005		EPA 524.2	135-98-8

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Systems Mgmt. Unit Mgr: George Krisztian

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DRINKING WATER LABORATORY

USEPA Region V Drinking Water Cert. No. MI00003
P.O. Box 30270
Lansing, MI 48909
TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LF54308

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Volatile Organic Compounds						
Styrene	Not Detected	02/13/2015	0.0005	0.1	EPA 524.2	100-42-5
tert-Butylbenzene	Not Detected	02/13/2015	0.0005		EPA 524.2	98-06-6
Tetrachloroethylene	Not Detected	02/13/2015	0.0005	0.005	EPA 524.2	127-18-4
Tetrahydrofuran	Not Detected	02/13/2015	0.005		EPA 524.2	109-99-9
Toluene	Not Detected	02/13/2015	0.0005	1	EPA 524.2	108-88-3
Total Trihalomethanes	0.014	02/13/2015	NA	0.080	EPA 524.2	TTHM-00-C
Total Xylenes	Not Detected	02/13/2015	NA	10	EPA 524.2	1330-20-7
trans-1,2 Dichloroethylene	Not Detected	02/13/2015	0.0005	0.1	EPA 524.2	156-60-5
trans-1,3 Dichloropropene	Not Detected	02/13/2015	0.0005		EPA 524.2	10061-02-6
Trichloroethylene	Not Detected	02/13/2015	0.0005	0.005	EPA 524.2	79-01-6
Vinyl chloride	Not Detected	02/13/2015	0.0005	0.002	EPA 524.2	75-01-4

The analyses performed by the MDEQ Drinking Water Laboratory were conducted using methods approved by the U .S. Environmental Protection Agency in accordance with the Safe Drinking Water Act, 40 CFR parts 141-143, and other regulatory agencies as appropriate.

Your local health department has detailed information about the quality of drinking water in your area. If you have concerns about the health risks related to the test results of your sample, please contact the Environmental Health Section through the address and telephone number listed below:

Berrien County
2106 South M-139
Benton Harbor, MI 49022
269 927-5623

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Sample Number
LF10432

Official Laboratory Report

Report To: STEWART A BEACH
601 N RIDGEWAY
ST JOSEPH MI 49085

System Name/Owner:	CITY OF BENTON HARBOR	WSSN/Pool ID:	0600
Collection Address:	601 N RIDGEWAY,ST JOSEPH	Source:	TYPE I
Collected By:	STEWART A BEACH	Site Code:	T P001
Township/Well#/Section:	//	Collector:	Public Water Supply Operator
County:	Berrien	Date Collected:	02/26/2014 09:00
Sample Point:	PLANT TAP	Date Received:	02/27/2014 10:55
Water System:	Treated Public Distribution System	Purpose:	Routine Monitoring

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Chloride	34	02/27/2014	4		SM 4500-Cl E	7647-14-5
Cyanide-Available	Not Detected	02/27/2014	0.02	0.2	OIA-1677	57-12-5
Fluoride	0.67	02/27/2014	0.1	4.0	SM 4500 FC	16984-48-8
Hardness as CaCO3	188	02/27/2014	20		SM 2340 C	HARD-00-C
Iron (automated)	Not detected	02/27/2014	0.1		SM 3500 FeB	7439-89-6
Nitrate as N	1.5	02/27/2014	0.4	10	10-107-04-2-B	14797-55-8
Nitrite as N	Not detected	02/27/2014	0.05	1	10-107-04-2-B	14797-65-0
Sodium (automated)	16	02/27/2014	5		SM 3500 NaB	7440-23-5
Sulfate	39	02/27/2014	10		SM 4500 SO4E	14808-79-8
Volatile Organic Compounds						
1,1 Dichloroethane	Not Detected	02/28/2014	0.0005		EPA 524.2	75-34-3
1,1 Dichloroethylene	Not Detected	02/28/2014	0.0005	0.007	EPA 524.2	75-35-4
1,1 Dichloropropene	Not Detected	02/28/2014	0.0005		EPA 524.2	563-58-6
1,1,1 Trichloroethane	Not Detected	02/28/2014	0.0005	0.2	EPA 524.2	71-55-6
1,1,1,2 Tetrachloroethane	Not Detected	02/28/2014	0.0005		EPA 524.2	630-20-6
1,1,2 Trichloroethane	Not Detected	02/28/2014	0.0005	0.005	EPA 524.2	79-00-5
1,1,2,2 Tetrachloroethane	Not Detected	02/28/2014	0.0005		EPA 524.2	79-34-5
1,2 Dichlorobenzene	Not Detected	02/28/2014	0.0005	0.6	EPA 524.2	95-50-1
1,2 Dichloroethane	Not Detected	02/28/2014	0.0005	0.005	EPA 524.2	107-06-2
1,2 Dichloropropane	Not Detected	02/28/2014	0.0005	0.005	EPA 524.2	78-87-5
1,2,3 Trichlorobenzene	Not Detected	02/28/2014	0.0005		EPA 524.2	87-61-6
1,2,3 Trichloropropane	Not Detected	02/28/2014	0.0005		EPA 524.2	96-18-4
1,2,4 Trichlorobenzene	Not Detected	02/28/2014	0.0005	0.07	EPA 524.2	120-82-1

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FAX: (517) 335-8562

Sample Number
LF10432

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Volatile Organic Compounds						
1,2,4 Trimethylbenzene	Not Detected	02/28/2014	0.0005		EPA 524.2	95-63-6
1,3 Dichlorobenzene	Not Detected	02/28/2014	0.0005		EPA 524.2	541-73-1
1,3 Dichloropropane	Not Detected	02/28/2014	0.0005		EPA 524.2	142-28-9
1,3,5 Trimethylbenzene	Not Detected	02/28/2014	0.0005		EPA 524.2	108-67-8
1,4 Dichlorobenzene	Not Detected	02/28/2014	0.0005	0.075	EPA 524.2	106-46-7
2,2 Dichloropropane	Not Detected	02/28/2014	0.0005		EPA 524.2	594-20-7
Benzene	Not Detected	02/28/2014	0.0005	0.005	EPA 524.2	71-43-2
Bromobenzene	Not Detected	02/28/2014	0.0005		EPA 524.2	108-86-1
Bromochloromethane	Not Detected	02/28/2014	0.0005		EPA 524.2	74-97-5
Bromodichloromethane	0.0097	02/28/2014	0.0005	0.080	EPA 524.2	75-27-4
Bromoform	Not Detected	02/28/2014	0.0005	0.080	EPA 524.2	75-25-2
Bromomethane	Not Detected	02/28/2014	0.001		EPA 524.2	74-83-9
Carbon tetrachloride	Not Detected	02/28/2014	0.0005	0.005	EPA 524.2	56-23-5
Chlorobenzene	Not Detected	02/28/2014	0.0005	0.1	EPA 524.2	108-90-7
Chlorodibromomethane	0.0016	02/28/2014	0.0005	0.080	EPA 524.2	124-48-1
Chloroethane	Not Detected	02/28/2014	0.0005		EPA 524.2	75-00-3
Chloroform	0.027	02/28/2014	0.0005	0.080	EPA 524.2	67-66-3
Chloromethane	Not Detected	02/28/2014	0.0005		EPA 524.2	74-87-3
cis-1,2 Dichloroethylene	Not Detected	02/28/2014	0.0005	0.07	EPA 524.2	156-59-2
cis-1,3 Dichloropropene	Not Detected	02/28/2014	0.0005		EPA 524.2	10061-01-5
Dibromomethane	Not Detected	02/28/2014	0.0005		EPA 524.2	74-95-3
Dichlorodifluoromethane	Not Detected	02/28/2014	0.001		EPA 524.2	75-71-8
Dichloromethane	Not Detected	02/28/2014	0.0006	0.005	EPA 524.2	75-09-2
Ethylbenzene	Not Detected	02/28/2014	0.0005	0.7	EPA 524.2	100-41-4
Fluorotrichloromethane	Not Detected	02/28/2014	0.001		EPA 524.2	75-69-4
Hexachlorobutadiene	Not Detected	02/28/2014	0.0005		EPA 524.2	87-68-3
Isopropylbenzene	Not Detected	02/28/2014	0.0005		EPA 524.2	98-82-8
m & p-Xylene	Not Detected	02/28/2014	0.0005	10	EPA 524.2	XYLMP-00-C
Methyl ethyl ketone	Not Detected	02/28/2014	0.005		EPA 524.2	78-93-3
Methyl isobutyl ketone	Not Detected	02/28/2014	0.005		EPA 524.2	108-10-1
Methyl-tert-butyl ether (MTBE)	Not Detected	02/28/2014	0.001		EPA 524.2	1634-04-4
Naphthalene	Not Detected	02/28/2014	0.0005		EPA 524.2	91-20-3
n-Butylbenzene	Not Detected	02/28/2014	0.0005		EPA 524.2	104-51-8
Nitrobenzene	Not Detected	02/28/2014	0.01		EPA 524.2	98-95-3
n-Propylbenzene	Not Detected	02/28/2014	0.0005		EPA 524.2	103-65-1
o-Chlorotoluene	Not Detected	02/28/2014	0.0005		EPA 524.2	95-49-8
o-Xylene	Not Detected	02/28/2014	0.0005	10	EPA 524.2	95-47-6
p-Chlorotoluene	Not Detected	02/28/2014	0.0005		EPA 524.2	106-43-4
p-Isopropyltoluene	Not Detected	02/28/2014	0.0005		EPA 524.2	99-87-6

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Lansing, MI 48909
TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LF10432

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Volatile Organic Compounds						
sec-Butylbenzene	Not Detected	02/28/2014	0.0005		EPA 524.2	135-98-8
Styrene	Not Detected	02/28/2014	0.0005	0.1	EPA 524.2	100-42-5
tert-Butylbenzene	Not Detected	02/28/2014	0.0005		EPA 524.2	98-06-6
Tetrachloroethylene	Not Detected	02/28/2014	0.0005	0.005	EPA 524.2	127-18-4
Tetrahydrofuran	Not Detected	02/28/2014	0.005		EPA 524.2	109-99-9
Toluene	Not Detected	02/28/2014	0.0005	1	EPA 524.2	108-88-3
Total Trihalomethanes	0.038	02/28/2014	NA	0.080	EPA 524.2	TTHM-00-C
Total Xylenes	Not Detected	02/28/2014	NA	10	EPA 524.2	1330-20-7
trans-1,2 Dichloroethylene	Not Detected	02/28/2014	0.0005	0.1	EPA 524.2	156-60-5
trans-1,3 Dichloropropene	Not Detected	02/28/2014	0.0005		EPA 524.2	10061-02-6
Trichloroethylene	Not Detected	02/28/2014	0.0005	0.005	EPA 524.2	79-01-6
Vinyl chloride	Not Detected	02/28/2014	0.0004	0.002	EPA 524.2	75-01-4

The analyses performed by the MDEQ Drinking Water Laboratory were conducted using methods approved by the U.S. Environmental Protection Agency in accordance with the Safe Drinking Water Act, 40 CFR parts 141-143, and other regulatory agencies as appropriate.

Your local health department has detailed information about the quality of drinking water in your area. If you have concerns about the health risks related to the test results of your sample, please contact the Environmental Health Section through the address and telephone number listed below:

Berrien County
2106 South M-139
Benton Harbor, MI 49022
269 927-5623

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FAX: (517) 335-8562

Sample Number
LE46080

Official Laboratory Report

Report To: STEWART A BEACH
601 N RIDGEWAY
ST JOSEPH MI 49085

System Name/Owner:	CITY OF BENTON HARBOR	WSSN/Pool ID:	0600
Collection Address:	601 N RIDGEWAY,ST JOSEPH	Source:	TYPE I
Collected By:	STEWART A BEACH	Site Code:	
Township/Well#/Section:	//	Collector:	Public Water Supply Operator
County:	Berrien	Date Collected:	09/04/2012
Sample Point:	LAB SINK RAW Plant Tap per Stewart Beach	Date Received:	09/05/2012 12:36
Water System:	Treated Public Distribution System	Purpose:	Routine Monitoring

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Carbamates by HPLC						
3 Hydroxycarbofuran	Not Detected	09/12/2012	0.001		EPA 531.2	16655-82-6
Aldicarb	Not Detected	09/12/2012	0.0005		EPA 531.2	116-06-3
Aldicarb sulfone	Not Detected	09/12/2012	0.0005		EPA 531.2	1646-88-4
Aldicarb sulfoxide	Not Detected	09/12/2012	0.0005		EPA 531.2	1646-87-3
Carbaryl	Not Detected	09/12/2012	0.001		EPA 531.2	63-25-2
Carbofuran	Not Detected	09/12/2012	0.0005	0.04	EPA 531.2	1563-66-2
Methiocarb	Not Detected	09/12/2012	0.001		EPA 531.2	2032-65-7
Methomyl	Not Detected	09/12/2012	0.001		EPA 531.2	16752-77-5
Oxamyl	Not Detected	09/12/2012	0.001	0.2	EPA 531.2	23135-22-0
Propoxur	Not Detected	09/12/2012	0.001		EPA 531.2	114-26-1
Chlorinated Acid Herbicides						
2,4,5-T	Not Detected	09/06/2012	0.002		EPA 515.4	93-76-5
2,4,5-TP (silvex)	Not Detected	09/06/2012	0.0003	0.05	EPA 515.4	93-72-1
2,4-D	Not Detected	09/06/2012	0.002	0.07	EPA 515.4	94-75-7
Acifluorfen	Not Detected	09/06/2012	0.004		EPA 515.4	50594-66-6
Bentazon	Not Detected	09/06/2012	0.002		EPA 515.4	25057-89-0
Dicamba	Not Detected	09/06/2012	0.002		EPA 515.4	1918-00-9
Dinoseb	Not Detected	09/06/2012	0.0003	0.007	EPA 515.4	88-85-7
Pentachlorophenol	Not Detected	09/06/2012	0.00006	0.001	EPA 515.4	87-86-5
Picloram	Not Detected	09/06/2012	0.001	0.5	EPA 515.4	1918-02-1
Total DCPA degradates, mono- and di-acid	Not Detected	09/06/2012	0.001		EPA 515.4	1861-32-1

Pesticides Analysis by GC/MS

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Sample Number
LE46080

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Pesticides Analysis by GC/MS						
4,4'-DDD	Not Detected	09/10/2012	0.001		EPA 525.2	72-54-8
4,4'-DDE	Not Detected	09/10/2012	0.001		EPA 525.2	72-55-9
4,4'-DDT	Not Detected	09/10/2012	0.0005		EPA 525.2	50-29-3
Acetochlor	Not Detected	09/10/2012	0.001		EPA 525.2	34256-82-1
Alachlor	Not Detected	09/10/2012	0.0002	0.002	EPA 525.2	15972-60-8
Aldrin	Not Detected	09/10/2012	0.0004		EPA 525.2	309-00-2
alpha-Chlordane	Not Detected	09/10/2012	0.0002	0.002	EPA 525.2	5103-71-9
Atrazine	Not Detected	09/10/2012	0.0002	0.003	EPA 525.2	1912-24-9
Dieldrin	Not Detected	09/10/2012	0.0005		EPA 525.2	60-57-1
Endrin	Not Detected	09/10/2012	0.0001	0.002	EPA 525.2	72-20-8
Endrin aldehyde	Not Detected	09/10/2012	0.001		EPA 525.2	7421-93-4
gamma-Chlordane	Not Detected	09/10/2012	0.0002	0.002	EPA 525.2	5103-74-2
Heptachlor	Not Detected	09/10/2012	0.0002	0.0004	EPA 525.2	76-44-8
Heptachlor epoxide	Not Detected	09/10/2012	0.0001	0.0002	EPA 525.2	1024-57-3
Hexachlorobenzene	Not Detected	09/10/2012	0.0001	0.001	EPA 525.2	118-74-1
Hexachlorocyclohexane (alpha-BHC)	Not Detected	09/10/2012	0.001		EPA 525.2	319-84-6
Hexachlorocyclohexane (beta-BHC)	Not Detected	09/10/2012	0.001		EPA 525.2	319-85-7
Hexachlorocyclohexane (delta-BHC)	Not Detected	09/10/2012	0.001		EPA 525.2	319-86-8
Hexachlorocyclopentadiene	Not Detected	09/10/2012	0.0005	0.05	EPA 525.2	77-47-4
Lindane (gamma-BHC)	Not Detected	09/10/2012	0.0001	0.0002	EPA 525.2	58-89-9
Methoxychlor	Not Detected	09/10/2012	0.0001	0.04	EPA 525.2	72-43-5
Metolachlor	Not Detected	09/10/2012	0.001		EPA 525.2	51218-45-2
Metribuzin	Not Detected	09/10/2012	0.001		EPA 525.2	21087-64-9
Molinate	Not Detected	09/10/2012	0.0005		EPA 525.2	2212-67-1
PCB (aroclor 1016)	Not Detected	09/10/2012	0.0001	0.0005	EPA 525.2	12674-11-2
PCB (aroclor 1221)	Not Detected	09/10/2012	0.0001	0.0005	EPA 525.2	11104-28-2
PCB (aroclor 1232)	Not Detected	09/10/2012	0.0001	0.0005	EPA 525.2	11141-16-5
PCB (aroclor 1242)	Not Detected	09/10/2012	0.0001	0.0005	EPA 525.2	53469-21-9
PCB (aroclor 1248)	Not Detected	09/10/2012	0.0001	0.0005	EPA 525.2	12672-29-6
PCB (aroclor 1254)	Not Detected	09/10/2012	0.0001	0.0005	EPA 525.2	11097-69-1
PCB (aroclor 1260)	Not Detected	09/10/2012	0.0001	0.0005	EPA 525.2	11096-82-5
Polybrominated biphenyls	Not Detected	09/10/2012	0.0001		EPA 525.2	59536-65-1
Simazine	Not Detected	09/10/2012	0.0002	0.004	EPA 525.2	122-34-9
Toxaphene	Not Detected	09/10/2012	0.001	0.003	EPA 525.2	8001-35-2

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CFU : Colony Forming Unit

Laboratory Contacts
Drinking Water Unit Mgr: Julia Pieper
Systems Mgmt. Unit Mgr: George Krisztian

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
DRINKING WATER LABORATORY
USEPA Region V Drinking Water Cert. No. MI00003
P.O. Box 30270
Lansing, MI 48909
TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LE46080

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #

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Berrien County
2106 South M-139
Benton Harbor, MI 49022
269 927-5623

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Sample Number
LE46086

Official Laboratory Report

Report To: STEWART A BEACH
601 N RIDGEWAY
ST JOSEPH MI 49085

System Name/Owner:	CITY OF BENTON HARBOR	WSSN/Pool ID:	0600
Collection Address:	601 N RIDGEWAY,BENTON HARBOR	Source:	TYPE I
Collected By:	STEWART A BEACH	Site Code:	TAP
Township/Well#/Section:	//	Collector:	Public Water Supply Operator
County:	Berrien	Date Collected:	09/04/2012
Sample Point:	TAP	Date Received:	09/05/2012 12:41
Water System:	Other	Purpose:	Routine Monitoring

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Volatile Organic Compounds						
1,1 Dichloroethane	Not Detected	09/12/2012	0.0005		EPA 524.2	75-34-3
1,1 Dichloroethylene	Not Detected	09/12/2012	0.0005	0.007	EPA 524.2	75-35-4
1,1 Dichloropropene	Not Detected	09/12/2012	0.0005		EPA 524.2	563-58-6
1,1,1 Trichloroethane	Not Detected	09/12/2012	0.0005	0.2	EPA 524.2	71-55-6
1,1,1,2 Tetrachloroethane	Not Detected	09/12/2012	0.0005		EPA 524.2	630-20-6
1,1,2 Trichloroethane	Not Detected	09/12/2012	0.0005	0.005	EPA 524.2	79-00-5
1,1,2,2 Tetrachloroethane	Not Detected	09/12/2012	0.0005		EPA 524.2	79-34-5
1,2 Dichlorobenzene	Not Detected	09/12/2012	0.0005	0.6	EPA 524.2	95-50-1
1,2 Dichloroethane	Not Detected	09/12/2012	0.0005	0.005	EPA 524.2	107-06-2
1,2 Dichloropropane	Not Detected	09/12/2012	0.0005	0.005	EPA 524.2	78-87-5
1,2,3 Trichlorobenzene	Not Detected	09/12/2012	0.0005		EPA 524.2	87-61-6
1,2,3 Trichloropropane	Not Detected	09/12/2012	0.0005		EPA 524.2	96-18-4
1,2,4 Trichlorobenzene	Not Detected	09/12/2012	0.0005	0.07	EPA 524.2	120-82-1
1,2,4 Trimethylbenzene	Not Detected	09/12/2012	0.0005		EPA 524.2	95-63-6
1,3 Dichlorobenzene	Not Detected	09/12/2012	0.0005		EPA 524.2	541-73-1
1,3 Dichloropropane	Not Detected	09/12/2012	0.0005		EPA 524.2	142-28-9
1,3,5 Trimethylbenzene	Not Detected	09/12/2012	0.0005		EPA 524.2	108-67-8
1,4 Dichlorobenzene	Not Detected	09/12/2012	0.0005	0.075	EPA 524.2	106-46-7
2,2 Dichloropropane	Not Detected	09/12/2012	0.0005		EPA 524.2	594-20-7
Benzene	Not Detected	09/12/2012	0.0005	0.005	EPA 524.2	71-43-2
Bromobenzene	Not Detected	09/12/2012	0.0005		EPA 524.2	108-86-1
Bromochloromethane	Not Detected	09/12/2012	0.0005		EPA 524.2	74-97-5
Bromodichloromethane	0.0092	09/12/2012	0.0005	0.080	EPA 524.2	75-27-4

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Sample Number
LE46086

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Volatile Organic Compounds						
Bromoform	0.0005	09/12/2012	0.0005	0.080	EPA 524.2	75-25-2
Bromomethane	Not Detected	09/12/2012	0.001		EPA 524.2	74-83-9
Carbon tetrachloride	Not Detected	09/12/2012	0.0005	0.005	EPA 524.2	56-23-5
Chlorobenzene	Not Detected	09/12/2012	0.0005	0.1	EPA 524.2	108-90-7
Chlorodibromomethane	0.0048	09/12/2012	0.0005	0.080	EPA 524.2	124-48-1
Chloroethane	Not Detected	09/12/2012	0.0005		EPA 524.2	75-00-3
Chloroform	0.016	09/12/2012	0.0005	0.080	EPA 524.2	67-66-3
Chloromethane	Not Detected	09/12/2012	0.0005		EPA 524.2	74-87-3
cis-1,2 Dichloroethylene	Not Detected	09/12/2012	0.0005	0.07	EPA 524.2	156-59-2
cis-1,3 Dichloropropene	Not Detected	09/12/2012	0.0005		EPA 524.2	10061-01-5
Dibromomethane	Not Detected	09/12/2012	0.0005		EPA 524.2	74-95-3
Dichlorodifluoromethane	Not Detected	09/12/2012	0.001		EPA 524.2	75-71-8
Dichloromethane	Not Detected	09/12/2012	0.0006	0.005	EPA 524.2	75-09-2
Ethylbenzene	Not Detected	09/12/2012	0.0005	0.7	EPA 524.2	100-41-4
Fluorotrichloromethane	Not Detected	09/12/2012	0.001		EPA 524.2	75-69-4
Hexachlorobutadiene	Not Detected	09/12/2012	0.0005		EPA 524.2	87-68-3
Isopropylbenzene	Not Detected	09/12/2012	0.0005		EPA 524.2	98-82-8
m & p-Xylene	Not Detected	09/12/2012	0.0005	10	EPA 524.2	XYLMP-00-C
Methyl ethyl ketone	Not Detected	09/12/2012	0.005		EPA 524.2	78-93-3
Methyl isobutyl ketone	Not Detected	09/12/2012	0.005		EPA 524.2	108-10-1
Methyl-tert-butyl ether (MTBE)	Not Detected	09/12/2012	0.001		EPA 524.2	1634-04-4
Naphthalene	Not Detected	09/12/2012	0.0005		EPA 524.2	91-20-3
n-Butylbenzene	Not Detected	09/12/2012	0.0005		EPA 524.2	104-51-8
Nitrobenzene	Not Detected	09/12/2012	0.01		EPA 524.2	98-95-3
n-Propylbenzene	Not Detected	09/12/2012	0.0005		EPA 524.2	103-65-1
o-Chlorotoluene	Not Detected	09/12/2012	0.0005		EPA 524.2	95-49-8
o-Xylene	Not Detected	09/12/2012	0.0005	10	EPA 524.2	95-47-6
p-Chlorotoluene	Not Detected	09/12/2012	0.0005		EPA 524.2	106-43-4
p-Isopropyltoluene	Not Detected	09/12/2012	0.0005		EPA 524.2	99-87-6
sec-Butylbenzene	Not Detected	09/12/2012	0.0005		EPA 524.2	135-98-8
Styrene	Not Detected	09/12/2012	0.0005	0.1	EPA 524.2	100-42-5
tert-Butylbenzene	Not Detected	09/12/2012	0.0005		EPA 524.2	98-06-6
Tetrachloroethylene	Not Detected	09/12/2012	0.0005	0.005	EPA 524.2	127-18-4
Tetrahydrofuran	Not Detected	09/12/2012	0.005		EPA 524.2	109-99-9
Toluene	Not Detected	09/12/2012	0.0005	1	EPA 524.2	108-88-3
Total Trihalomethanes	0.031	09/12/2012	NA	0.080	EPA 524.2	TTHM-00-C
Total Xylenes	Not Detected	09/12/2012	NA	10	EPA 524.2	1330-20-7
trans-1,2 Dichloroethylene	Not Detected	09/12/2012	0.0005	0.1	EPA 524.2	156-60-5

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Systems Mgmt. Unit Mgr: George Krisztian

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FAX: (517) 335-8562

Sample Number
LE46086

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Volatile Organic Compounds						
trans-1,3 Dichloropropene	Not Detected	09/12/2012	0.0005		EPA 524.2	10061-02-6
Trichloroethylene	Not Detected	09/12/2012	0.0005	0.005	EPA 524.2	79-01-6
Vinyl chloride	Not Detected	09/12/2012	0.0004	0.002	EPA 524.2	75-01-4

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269 927-5623

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GKW

Sample Number
LE46087

Official Laboratory Report

Report To: STEWART A BEACH
601 N RIDGEWAY
ST JOSEPH MI 49085

System Name/Owner:	CITY OF BENTON HARBOR	WSSN/Pool ID:	0600
Collection Address:	601 N RIDGEWAY,ST JOSEPH	Source:	TYPE I
Collected By:	STEWART A BEACH	Site Code:	TAP
Township/Well#/Section:	//	Collector:	Public Water Supply Operator
County:	Berrien	Date Collected:	09/04/2012
Sample Point:	TAP	Date Received:	09/05/2012 12:41
Water System:	Public System Surface Water	Purpose:	Routine Monitoring

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Antimony	Not detected	09/14/2012	0.0006	0.006	EPA 200.8	7440-36-0
Arsenic	Not detected	09/14/2012	0.002	0.010	EPA 200.8	7440-38-2
Barium	0.02	09/14/2012	0.01	2	EPA 200.8	7440-39-3
Beryllium	Not detected	09/14/2012	0.0004	0.004	EPA 200.8	7440-41-7
Cadmium	Not detected	09/14/2012	0.0003	0.005	EPA 200.8	7440-43-9
Chromium	Not detected	09/14/2012	0.01	0.1	EPA 200.8	7440-47-3
Lead	Not detected	09/14/2012	0.001	0.015	EPA 200.8	7439-92-1
Mercury	Not detected	09/14/2012	0.0001	0.002	EPA 200.8	7439-97-6
Nickel	Not detected	09/14/2012	0.01	0.1	EPA 200.8	7440-02-0
Selenium	Not detected	09/14/2012	0.001	0.05	EPA 200.8	7782-49-2
Thallium	Not detected	09/14/2012	0.0002	0.002	EPA 200.8	7440-28-0

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USEPA Region V Drinking Water Cert. No. MI00003
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Lansing, MI 48909
TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LE34693

Official Laboratory Report

Report To: STEWART A BEACH BHW
601 N RIDGEWAY
ST JOSEPH MI 49085

System Name/Owner:	CITY OF BENTON HARBOR	WSSN/Pool ID:	0600
Collection Address:	601 N RIDGEWAY,ST JOSEPH	Source:	TYPE I
Collected By:	STEWART A BEACH	Site Code:	
Township/Well#/Section:	//	Collector:	Public Water Supply Operator
County:	Berrien	Date Collected:	06/29/2012 11:00
Sample Point:	LAB SINK RAW	Date Received:	06/30/2012 10:12
Water System:	Pressure Tank/Plant Tap	Purpose:	Routine Monitoring

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Carbamates by HPLC						
3 Hydroxycarbofuran	Not Detected	07/03/2012	0.001		EPA 531.2	16655-82-6
Aldicarb	Not Detected	07/03/2012	0.0005		EPA 531.2	116-06-3
Aldicarb sulfone	Not Detected	07/03/2012	0.0005		EPA 531.2	1646-88-4
Aldicarb sulfoxide	Not Detected	07/03/2012	0.0005		EPA 531.2	1646-87-3
Carbaryl	Not Detected	07/03/2012	0.001		EPA 531.2	63-25-2
Carbofuran	Not Detected	07/03/2012	0.0005	0.04	EPA 531.2	1563-66-2
Methiocarb	Not Detected	07/03/2012	0.001		EPA 531.2	2032-65-7
Methomyl	Not Detected	07/03/2012	0.001		EPA 531.2	16752-77-5
Oxamyl	Not Detected	07/03/2012	0.001	0.2	EPA 531.2	23135-22-0
Propoxur	Not Detected	07/03/2012	0.001		EPA 531.2	114-26-1
Chlorinated Acid Herbicides						
2,4,5-T	Not Detected	07/11/2012	0.002		EPA 515.4	93-76-5
2,4,5-TP (silvex)	Not Detected	07/11/2012	0.0003	0.05	EPA 515.4	93-72-1
2,4-D	Not Detected	07/11/2012	0.002	0.07	EPA 515.4	94-75-7
Acifluorfen	Not Detected	07/11/2012	0.004		EPA 515.4	50594-66-6
Bentazon	Not Detected	07/11/2012	0.002		EPA 515.4	25057-89-0
Dicamba	Not Detected	07/11/2012	0.002		EPA 515.4	1918-00-9
Dinoseb	Not Detected	07/11/2012	0.0003	0.007	EPA 515.4	88-85-7
Pentachlorophenol	Not Detected	07/11/2012	0.00006	0.001	EPA 515.4	87-86-5
Picloram	Not Detected	07/11/2012	0.001	0.5	EPA 515.4	1918-02-1
Total DCPA degradates, mono- and di-acid	Not Detected	07/11/2012	0.001		EPA 515.4	1861-32-1

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Sample Number
LE34693

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Pesticides Analysis by GC/MS						
4,4'-DDD	Not Detected	07/03/2012	0.001		EPA 525.2	72-54-8
4,4'-DDE	Not Detected	07/03/2012	0.001		EPA 525.2	72-55-9
4,4'-DDT	Not Detected	07/03/2012	0.0005		EPA 525.2	50-29-3
Acetochlor	Not Detected	07/03/2012	0.001		EPA 525.2	34256-82-1
Alachlor	Not Detected	07/03/2012	0.0002	0.002	EPA 525.2	15972-60-8
Aldrin	Not Detected	07/03/2012	0.0004		EPA 525.2	309-00-2
alpha-Chlordane	Not Detected	07/03/2012	0.0002	0.002	EPA 525.2	5103-71-9
Atrazine	Not Detected	07/03/2012	0.0002	0.003	EPA 525.2	1912-24-9
Dieldrin	Not Detected	07/03/2012	0.0005		EPA 525.2	60-57-1
Endrin	Not Detected	07/03/2012	0.0001	0.002	EPA 525.2	72-20-8
Endrin aldehyde	Not Detected	07/03/2012	0.001		EPA 525.2	7421-93-4
gamma-Chlordane	Not Detected	07/03/2012	0.0002	0.002	EPA 525.2	5103-74-2
Heptachlor	Not Detected	07/03/2012	0.0002	0.0004	EPA 525.2	76-44-8
Heptachlor epoxide	Not Detected	07/03/2012	0.0001	0.0002	EPA 525.2	1024-57-3
Hexachlorobenzene	Not Detected	07/03/2012	0.0001	0.001	EPA 525.2	118-74-1
Hexachlorocyclohexane (alpha-BHC)	Not Detected	07/03/2012	0.001		EPA 525.2	319-84-6
Hexachlorocyclohexane (beta-BHC)	Not Detected	07/03/2012	0.001		EPA 525.2	319-85-7
Hexachlorocyclohexane (delta-BHC)	Not Detected	07/03/2012	0.001		EPA 525.2	319-86-8
Hexachlorocyclopentadiene	Not Detected	07/03/2012	0.0005	0.05	EPA 525.2	77-47-4
Lindane (gamma-BHC)	Not Detected	07/03/2012	0.0001	0.0002	EPA 525.2	58-89-9
Methoxychlor	Not Detected	07/03/2012	0.0001	0.04	EPA 525.2	72-43-5
Metolachlor	Not Detected	07/03/2012	0.001		EPA 525.2	51218-45-2
Metribuzin	Not Detected	07/03/2012	0.001		EPA 525.2	21087-64-9
Molinate	Not Detected	07/03/2012	0.0005		EPA 525.2	2212-67-1
PCB (aroclor 1016)	Not Detected	07/03/2012	0.0001	0.0005	EPA 525.2	12674-11-2
PCB (aroclor 1221)	Not Detected	07/03/2012	0.0001	0.0005	EPA 525.2	11104-28-2
PCB (aroclor 1232)	Not Detected	07/03/2012	0.0001	0.0005	EPA 525.2	11141-16-5
PCB (aroclor 1242)	Not Detected	07/03/2012	0.0001	0.0005	EPA 525.2	53469-21-9
PCB (aroclor 1248)	Not Detected	07/03/2012	0.0001	0.0005	EPA 525.2	12672-29-6
PCB (aroclor 1254)	Not Detected	07/03/2012	0.0001	0.0005	EPA 525.2	11097-69-1
PCB (aroclor 1260)	Not Detected	07/03/2012	0.0001	0.0005	EPA 525.2	11096-82-5
Polybrominated biphenyls	Not Detected	07/03/2012	0.0001		EPA 525.2	59536-65-1
Simazine	Not Detected	07/03/2012	0.0002	0.004	EPA 525.2	122-34-9
Toxaphene	Not Detected	07/03/2012	0.001	0.003	EPA 525.2	8001-35-2

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Sample Number
LE34693

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #

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Sample Number
LE29481

Official Laboratory Report

Report To: BENTON HARBOR WATER - M OMALLE
200 E WELL ST
BENTON HARBOR MI 49022

System Name/Owner:	BENTON HARBOR WATER PLANT	WSSN/Pool ID:	0600
Collection Address:	601 RIDJWY,ST JOSEPH	Source:	TYPE I
Collected By:	MIKE OMALLEY	Site Code:	IN PLANT
Township/Well#/Section:	//	Collector:	Public Water Supply Operator
County:	Berrien	Date Collected:	05/29/2012 14:00
Sample Point:	PLANT TAP	Date Received:	05/30/2012 11:27
Water System:	Public System Surface Water	Purpose:	Routine Monitoring

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Chloride	18	05/30/2012	4		SM 4500-Cl E	7647-14-5
Fluoride	0.68	05/30/2012	0.1	4.0	SM 4500 FC	16984-48-8
Hardness as CaCO3	141	05/30/2012	20		SM 2340 C	HARD-00-C
Iron (automated)	Not detected	05/30/2012	0.1		SM 3500 FeB	7439-89-6
Nitrate as N	Not Detected	05/30/2012	0.4	10	SM 4500 NO3H	14797-55-8
Nitrite as N	Not detected	05/30/2012	0.05	1	SM 4500 NO3H	14797-65-0
Sodium (automated)	8	05/30/2012	5		SM 3500 NaB	7440-23-5
Sulfate	28	05/30/2012	10		SM 4500 SO4E	14808-79-8

The analyses performed by the MDEQ Drinking Water Laboratory were conducted using methods approved by the U.S. Environmental Protection Agency in accordance with the Safe Drinking Water Act, 40 CFR parts 141-143, and other regulatory agencies as appropriate.

Your local health department has detailed information about the quality of drinking water in your area. If you have concerns about the health risks related to the test results of your sample, please contact the Environmental Health Section through the address and telephone number listed below:

Berrien County
2106 South M-139
Benton Harbor, MI 49022
269 927-5623

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MCL : Maximum Contaminant Level
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RL : Reporting Limit

mg/L : milligrams / Liter (ppm)
ppm : parts per million
MPN : Most Probable Number
CFU : Colony Forming Unit

Laboratory Contacts
Drinking Water Unit Mgr: Julia Pieper
Systems Mgmt. Unit Mgr: George Krisztian

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
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USEPA Region V Drinking Water Cert. No. MI00003
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Lansing, MI 48909
TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LE02810

Official Laboratory Report

Report To: MIKE OMALLEY
601 N RIDGEWAY
ST JOSEPH MI 49085

System Name/Owner:	CITY OF BENTON HARBOR	WSSN/Pool ID:	0600
Collection Address:	,BENTON HARBOR	Source:	TYPE II
Collected By:	FRANK HUFF	Site Code:	
Township/Well#/Section:	BENTON TOWNSHIP//	Collector:	Public Water Supply Operator
County:	Berrien	Date Collected:	09/26/2011 13:30
Sample Point:	Plant Tap - per Mike O'Malley	Date Received:	09/27/2011 12:52
Water System:	Other	Purpose:	Routine Monitoring

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Chloride	19	09/27/2011	4		SM 4500-Cl E	7647-14-5
Fluoride	0.78	09/27/2011	0.1	4.0	SM 4500 FC	16984-48-8
Hardness as CaCO3	187	09/27/2011	20		SM 2340 C	HARD-00-C
Iron (automated)	Not detected	09/27/2011	0.1		SM 3500 FeB	7439-89-6
Nitrate as N	Not Detected	09/27/2011	0.4	10	SM 4500 NO3H	14797-55-8
Nitrite as N	Not detected	09/27/2011	0.05	1	SM 4500 NO3H	14797-65-0
Sodium (automated)	10	09/27/2011	5		SM 3500 NaB	7440-23-5
Sulfate	33	09/27/2011	10		SM 4500 SO4E	14808-79-8
Dalapon and Haloacetic						
Bromoacetic acid	Not Detected	09/30/2011	0.001		EPA 552.1/552.2	79-08-3
Bromochloroacetic acid	0.003	09/30/2011	0.001		EPA 552.1/552.2	5589-96-3
Chloroacetic acid	Not Detected	09/30/2011	0.002		EPA 552.1/552.2	79-11-8
Dalapon	Not Detected	09/30/2011	0.001	0.2	EPA 552.1/552.2	75-99-0
Dibromoacetic acid	Not Detected	09/30/2011	0.001		EPA 552.1/552.2	631-64-1
Dichloroacetic acid	0.012	09/30/2011	0.001		EPA 552.1/552.2	79-43-6
Total Haloacetic Acids (five)	0.023	09/30/2011	0.01	0.060	EPA 552.1/552.2	THA-00-C
Trichloroacetic acid	0.011	09/30/2011	0.001		EPA 552.1/552.2	76-03-9
Volatile Organic Compounds						
1,1 Dichloroethane	Not Detected	09/29/2011	0.0005		EPA 524.2	75-34-3
1,1 Dichloroethylene	Not Detected	09/29/2011	0.0005	0.007	EPA 524.2	75-35-4
1,1 Dichloropropene	Not Detected	09/29/2011	0.0005		EPA 524.2	563-58-6
1,1,1 Trichloroethane	Not Detected	09/29/2011	0.0005	0.2	EPA 524.2	71-55-6
1,1,1,2 Tetrachloroethane	Not Detected	09/29/2011	0.0005		EPA 524.2	630-20-6

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TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LE02810

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Volatile Organic Compounds						
1,1,2 Trichloroethane	Not Detected	09/29/2011	0.0005	0.005	EPA 524.2	79-00-5
1,1,2,2 Tetrachloroethane	Not Detected	09/29/2011	0.0005		EPA 524.2	79-34-5
1,2 Dichlorobenzene	Not Detected	09/29/2011	0.0005	0.6	EPA 524.2	95-50-1
1,2 Dichloroethane	Not Detected	09/29/2011	0.0005	0.005	EPA 524.2	107-06-2
1,2 Dichloropropane	Not Detected	09/29/2011	0.0005	0.005	EPA 524.2	78-87-5
1,2,3 Trichlorobenzene	Not Detected	09/29/2011	0.0005		EPA 524.2	87-61-6
1,2,3 Trichloropropane	Not Detected	09/29/2011	0.0005		EPA 524.2	96-18-4
1,2,4 Trichlorobenzene	Not Detected	09/29/2011	0.0005	0.07	EPA 524.2	120-82-1
1,2,4 Trimethylbenzene	Not Detected	09/29/2011	0.0005		EPA 524.2	95-63-6
1,3 Dichlorobenzene	Not Detected	09/29/2011	0.0005		EPA 524.2	541-73-1
1,3 Dichloropropane	Not Detected	09/29/2011	0.0005		EPA 524.2	142-28-9
1,3,5 Trimethylbenzene	Not Detected	09/29/2011	0.0005		EPA 524.2	108-67-8
1,4 Dichlorobenzene	Not Detected	09/29/2011	0.0005	0.075	EPA 524.2	106-46-7
2,2 Dichloropropane	Not Detected	09/29/2011	0.0005		EPA 524.2	594-20-7
Benzene	Not Detected	09/29/2011	0.0005	0.005	EPA 524.2	71-43-2
Bromobenzene	Not Detected	09/29/2011	0.0005		EPA 524.2	108-86-1
Bromochloromethane	Not Detected	09/29/2011	0.0005		EPA 524.2	74-97-5
Bromodichloromethane	0.0072	09/29/2011	0.0005	0.080	EPA 524.2	75-27-4
Bromoform	Not Detected	09/29/2011	0.0005	0.080	EPA 524.2	75-25-2
Bromomethane	Not Detected	09/29/2011	0.001		EPA 524.2	74-83-9
Carbon tetrachloride	Not Detected	09/29/2011	0.0005	0.005	EPA 524.2	56-23-5
Chlorobenzene	Not Detected	09/29/2011	0.0005	0.1	EPA 524.2	108-90-7
Chlorodibromomethane	0.0037	09/29/2011	0.0005	0.080	EPA 524.2	124-48-1
Chloroethane	Not Detected	09/29/2011	0.0005		EPA 524.2	75-00-3
Chloroform	0.0093	09/29/2011	0.0005	0.080	EPA 524.2	67-66-3
Chloromethane	Not Detected	09/29/2011	0.0005		EPA 524.2	74-87-3
cis-1,2 Dichloroethylene	Not Detected	09/29/2011	0.0005	0.07	EPA 524.2	156-59-2
cis-1,3 Dichloropropene	Not Detected	09/29/2011	0.0005		EPA 524.2	10061-01-5
Dibromomethane	Not Detected	09/29/2011	0.0005		EPA 524.2	74-95-3
Dichlorodifluoromethane	Not Detected	09/29/2011	0.001		EPA 524.2	75-71-8
Dichloromethane	Not Detected	09/29/2011	0.0006	0.005	EPA 524.2	75-09-2
Ethylbenzene	Not Detected	09/29/2011	0.0005	0.7	EPA 524.2	100-41-4
Fluorotrichloromethane	Not Detected	09/29/2011	0.001		EPA 524.2	75-69-4
Hexachlorobutadiene	Not Detected	09/29/2011	0.0005		EPA 524.2	87-68-3
Isopropylbenzene	Not Detected	09/29/2011	0.0005		EPA 524.2	98-82-8
m & p-Xylene	Not Detected	09/29/2011	0.0005	10	EPA 524.2	XYLMP-00-C
Methyl ethyl ketone	Not Detected	09/29/2011	0.005		EPA 524.2	78-93-3
Methyl isobutyl ketone	Not Detected	09/29/2011	0.005		EPA 524.2	108-10-1

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Laboratory Contacts
Drinking Water Unit Mgr: Julia Pieper
Systems Mgmt. Unit Mgr: George Krsztian

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DRINKING WATER LABORATORY

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Lansing, MI 48909
TEL: (517) 335-8184
FAX: (517) 335-8562

Sample Number
LE02810

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Volatile Organic Compounds						
Methyl-tert-butyl ether (MTBE)	Not Detected	09/29/2011	0.001		EPA 524.2	1634-04-4
Naphthalene	Not Detected	09/29/2011	0.0005		EPA 524.2	91-20-3
n-Butylbenzene	Not Detected	09/29/2011	0.0005		EPA 524.2	104-51-8
Nitrobenzene	Not Detected	09/29/2011	0.01		EPA 524.2	98-95-3
n-Propylbenzene	Not Detected	09/29/2011	0.0005		EPA 524.2	103-65-1
o-Chlorotoluene	Not Detected	09/29/2011	0.0005		EPA 524.2	95-49-8
o-Xylene	Not Detected	09/29/2011	0.0005	10	EPA 524.2	95-47-6
p-Chlorotoluene	Not Detected	09/29/2011	0.0005		EPA 524.2	106-43-4
p-Isopropyltoluene	Not Detected	09/29/2011	0.0005		EPA 524.2	99-87-6
sec-Butylbenzene	Not Detected	09/29/2011	0.0005		EPA 524.2	135-98-8
Styrene	Not Detected	09/29/2011	0.0005	0.1	EPA 524.2	100-42-5
tert-Butylbenzene	Not Detected	09/29/2011	0.0005		EPA 524.2	98-06-6
Tetrachloroethylene	Not Detected	09/29/2011	0.0005	0.005	EPA 524.2	127-18-4
Tetrahydrofuran	Not Detected	09/29/2011	0.005		EPA 524.2	109-99-9
Toluene	Not Detected	09/29/2011	0.0005	1	EPA 524.2	108-88-3
Total Trihalomethanes	0.020	09/29/2011	NA	0.080	EPA 524.2	TTHM-00-C
Total Xylenes	Not Detected	09/29/2011	NA	10	EPA 524.2	1330-20-7
trans-1,2 Dichloroethylene	Not Detected	09/29/2011	0.0005	0.1	EPA 524.2	156-60-5
trans-1,3 Dichloropropene	Not Detected	09/29/2011	0.0005		EPA 524.2	10061-02-6
Trichloroethylene	Not Detected	09/29/2011	0.0005	0.005	EPA 524.2	79-01-6
Vinyl chloride	Not Detected	09/29/2011	0.0004	0.002	EPA 524.2	75-01-4

The analyses performed by the MDEQ Drinking Water Laboratory were conducted using methods approved by the U.S. Environmental Protection Agency in accordance with the Safe Drinking Water Act, 40 CFR parts 141-143, and other regulatory agencies as appropriate.

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GRW

Sample Number
LD86624

Official Laboratory Report

Report To: BENTON HARBOR WATER- MICHAEL O
200 E WALL ST
BENTON HARBOR MI 49022

System Name/Owner:		WSSN/Pool ID:	0600
Collection Address:	LAKE MI CLLGE MENDEL/BHNN PLANT,BE	Source:	TYPE I
Collected By:	MICHAEL O`MALLEY	Site Code:	DBP - DIST/PLANT TAP
Township/Well#/Section:	//	Collector:	Other
County:	Berrien	Date Collected:	6/23/11
Sample Point:	KITCHEN/PLANT TAP	Date Received:	06/24/2011 12:05
Water System:	Public System Surface Water	Purpose:	Routine Monitoring

per Mike O'Malley

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Chloride	18	06/24/2011	4		SM 4500-Cl E	7647-14-5
Fluoride	0.75	06/24/2011	0.1	4.0	SM 4500 FC	16984-48-8
Hardness as CaCO3	133	06/24/2011	20		SM 2340 C	HARD-00-C
Iron (automated)	Not detected	06/24/2011	0.1		SM 3500 FeB	7439-89-6
Nitrate as N	Not Detected	06/24/2011	0.4	10	SM 4500 NO3H	14797-55-8
Nitrite as N	Not detected	06/24/2011	0.05	1	SM 4500 NO3H	14797-65-0
Sample collection date was not given or incorrect date given. Results will be evaluated by regulating agency.						
Sodium (automated)	8	06/24/2011	5		SM 3500 NaB	7440-23-5
Sulfate	29	06/24/2011	10		SM 4500 SO4E	14808-79-8
Dalapon and Haloacetic						
Bromoacetic acid	Not Detected	06/29/2011	0.001		EPA 552.1/552.2	79-08-3
Bromochloroacetic acid	0.004	06/29/2011	0.001		EPA 552.1/552.2	5589-96-3
Chloroacetic acid	Not Detected	06/29/2011	0.002		EPA 552.1/552.2	79-11-8
Dalapon	Not Detected	06/29/2011	0.001	0.2	EPA 552.1/552.2	75-99-0
Dibromoacetic acid	Not Detected	06/29/2011	0.001		EPA 552.1/552.2	631-64-1
Dichloroacetic acid	0.015	06/29/2011	0.001		EPA 552.1/552.2	79-43-6
Total Haloacetic Acids (five)	0.031	06/29/2011	0.01	0.060	EPA 552.1/552.2	THA-00-C
Trichloroacetic acid	0.016	06/29/2011	0.001		EPA 552.1/552.2	76-03-9
Sample collection date was not given or incorrect date given. Results will be evaluated by regulating agency.						
Total Trihalomethanes						
Bromodichloromethane	0.011	06/27/2011	0.0005	0.080	EPA 524.2	75-27-4
Bromoform	Not Detected	06/27/2011	0.0005	0.080	EPA 524.2	75-25-2
Chlorodibromomethane	0.0033	06/27/2011	0.0005	0.080	EPA 524.2	124-48-1
Chloroform	0.033	06/27/2011	0.0005	0.080	EPA 524.2	67-66-3

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Laboratory Contacts
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Systems Mgmt. Unit Mgr: George Krisztian

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Sample Number
LD86624

TESTING INFORMATION			REGULATORY INFORMATION			
Analyte Name	Result (mg/L)	Date Tested	RL (mg/L)	MCL/AL (mg/L)	Method	CAS #
Total Trihalomethanes						
Total Trihalomethanes	0.0470	06/27/2011	0.0005	0.080	EPA 524.2	TTHM-00-C

Sample collection date was not given or incorrect date given. Results will be evaluated by regulating agency.

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City of Benton Harbor
Disinfection Byproduct History
DBP2 B and Z Construction

Result Type	Date	TTHM (ppb)	RAA TTHM	HAA5 (ppb)	RAA TTHM	Location	TOC Source	TOC Treated	Notes
Individual	21-Nov-13	31.8	#N/A	13.0	#N/A	B&Z Construction Milton St	1.59	1.28	
Individual	26-Feb-14	35.0	#N/A	21.0	#N/A	B&Z Construction Milton St	3.83	2.88	
Individual	29-May-14	25.9	#N/A	15.0	#N/A	B&Z Construction Milton St	1.68	1.62	
Individual	05-Sep-14		30.9		16.3	B&Z Construction Milton St	1.54	1.34	M/R V samples required in Aug, sampled in September
Individual	19-Nov-14	33.7	31.5	15.0	17.0	B&Z Construction Milton St	1.53	1.31	
Individual	28-Feb-15	21.0	26.9	13.0	14.3	B&Z Construction Milton St	2.11	1.73	

City of Benton Harbor
Disinfection Byproduct History
DBP1--Blue Water Thermal

Result Type	Date	TTHM (ppb)	RAA TTHM	HAA5 (ppb)	RAA TTHM	Location	TOC Source	TOC Treated	Notes
Individual	14-Dec-11	50.0	#N/A	39.0	#N/A	Blue Water Thermal	NS	NS	
Individual	15-Mar-12	33.0	#N/A	33.0	#N/A	Blue Water Thermal	2.85	1.86	
Individual	29-May-12	25.0	#N/A	18.0	#N/A	Blue Water Thermal	1.9	1.32	
Individual	11-Sep-12	34.0	35.5	20.0	27.5	Blue Water Thermal	1.76	1.44	
Individual	21-Dec-12	20.0	28.0	15.0	21.5	Blue Water Thermal	1.42	1.11	
Individual	28-Mar-13	20.2	24.8	13.0	16.5	Blue Water Thermal	1.64	1.36	
Individual	27-Jun-13	30.8	26.3	11.0	14.8	Blue Water Thermal	1.47	1.2	
Individual	17-Sep-13	30.0	25.3	11.0	12.5	Blue Water Thermal	1.49	1.33	
Individual	21-Nov-13	27.6	27.2	1.0	9.0	Blue Water Thermal	1.59	1.28	Stage 2 starts
Individual	26-Feb-14	32.6	30.3	37.0	15.0	Blue Water Thermal	3.83	2.88	
Individual	28-May-14	25.2	28.9	**139.0**	47.0	Blue Water Thermal	1.68	1.62	
Individual	05-Sep-14		28.5		59.0	Blue Water Thermal	1.54	1.34	M/R V TTHM/HAA5 samples required in Aug, Sampled in Sept
Individual	19-Nov-14	32.3	30.0	17.0	**64.3**	Blue Water Thermal	1.53	1.31	MCL Violation
Individual	28-Feb-15	23.0	26.8	13.0	56.3	Empire and Fair DBP1 (Bluewater)	2.11	1.73	

Enhanced Coagulation/Softening Requirements

Supply: [Benton Harbor]
WSSN: 0600

Source TOC	Source Water Alkalinity 0-60	>60-120	>120
>2.0-4.0	35.0%	25.0%	15.0%
>4.0-8.0	45.0%	35.0%	25.0%
>8.0	50.0%	40.0%	30.0%

Alternative Compliance Criteria (ACC) Rule 610c(1)(b)-(c)
- Source or Treated TOC RAA <2.0, OR
- Source TOC RAA >4.0 & Alk RAA >60 **AND** TTHM & HAA5 RAA <= 40/30 respectively, OR
- TTHM & HAA5 <=40/30 & only Cl primary disinfectant... **And more ACCs.**

	A	B	C	D	E	F	G		H	I			May Reduce If Either ...			
Month	Treated TOC (mg/L)	Source TOC (mg/L)	(1-A/B) x 100	Source Water Alkalinity (mg/L)	Required TOC Removal (%)	C/E Actual Removal Ratio	Credit 1.0 if Paired Sample Source or Treated TOC <2.0	Credit 1.0 if RAA Source or Treated TOC <2.0	Rem'l Ratio Qtly	Rem'l Ratio RAA	Source TOC Qtly Ave	Source TOC RAA	Treated TOC Qtly Ave	1 Yr Treated RAA <1.0	2 Yr Treated RAA <2.0	Compliance with Treatment Technique (TT)
														Rule 719e(4)(b)		
January 2013																
February 2013																
March 2013	1.36	1.64	17.073	107	25	0.683	1.000	1.000	1.000	1.000	1.640	1.738	1.360	1.391	1.583	Met ACC
April 2013																
May 2013																
June 2013	1.20	1.47	18.367	101	25	0.735	1.000	1.000	1.000	1.000	1.470	1.630	1.200	1.361	1.500	Met ACC
July 2013																
August 2013																
September 2013	1.33	1.49	10.738	104	25	0.430	1.000	1.000	1.000	1.000	1.490	1.533	1.330	1.334	1.435	Met ACC
October 2013																
November 2013	1.28	1.59	19.497	102	25	0.780	1.000	1.000								
December 2013									1.000	1.000	1.590	1.548	1.280	1.293	1.415	Met ACC

:nhanced Coagulation/Softening
tequirements
:upply: [Benton Harbor]
VSSN: 0600

Source Water Alkalinity			
Source TOC	0-60	>60-120	>120
>2.0-4.0	35.0%	25.0%	15.0%
>4.0-8.0	45.0%	35.0%	25.0%
>8.0	50.0%	40.0%	30.0%

Alternative Compliance Criteria (ACC) Rule 610c(1)(b)-(c)
- Source or Treated TOC RAA <2.0, **OR**
- Source TOC RAA >4.0 & Alk RAA >60 **AND**
  TTHM & HAA5 RAA <= 40/30 respectively, **OR**
- TTHM & HAA5 <=40/30 & only Cl primary disinfectant... **And more ACCs.**

	A	B	C	D	E	F	G		H	I	May Reduce If Either ...					
Month	Treated TOC (mg/L)	Source TOC (mg/L)	(1-A/B) x 100	Source Water Alkalinity (mg/L)	Required TOC Removal (%)	C/E Actual Removal Ratio	Credit 1.0 if Paired Sample Source or Treated TOC <2.0	Credit 1.0 if RAA Source or Treated TOC <2.0	Rem'l Ratio Qtly	Rem'l Ratio RAA	Source TOC Qtly Ave	Source TOC RAA	Treated TOC Qtly Ave	1 Yr Treated RAA <1.0	2 Yr Treated RAA <2.0	Compliance with Treatment Technique (TT)
											Rule 719e(4)(b)					
anuary 2014																
ebruary 2014	2.88	3.83	24.804	131	15	1.654	1.654	1.163								
larch 2014									3.830	2.095	3.830	2.095	2.880	1.673	1.532	Met ACC
pril 2014																
lay 2014	1.62	1.68	3.571	111	25	0.143	1.000	1.000								
une 2014	1.38	1.57	12.102	100	25	0.484	1.000	1.000	1.000	1.163	1.625	2.134	1.500	1.748	1.554	Met ACC
uly 2014																
ugust 2014																
eptember 2014	1.34	1.54	12.987	108	25	0.519	1.000	1.000	1.000	1.163	1.540	2.146	1.340	1.750	1.542	Met ACC
ctober 2014																
lovember 2014	1.31	1.53	14.379	106	25	0.575	1.000	1.000								
ecember 2014									1.000	1.163	1.530	2.131	1.310	1.758	1.525	Met ACC

Enhanced Coagulation/Softening Requirements
Supply: [Benton Harbor]
PWSSN: 0600

Source TOC	Source Water Alkalinity 0-60	>60-120	>120
>2.0-4.0	35.0%	25.0%	15.0%
>4.0-8.0	45.0%	35.0%	25.0%
>8.0	50.0%	40.0%	30.0%

Alternative Compliance Criteria (ACC) Rule 610c(1)(b)-(c)
- Source or Treated TOC RAA <2.0, **OR**
- Source TOC RAA >4.0 & Alk RAA >60 **AND** TTHM & HAA5 RAA <= 40/30 respectively, **OR**
- TTHM & HAA5 <=40/30 **&** only Cl primary disinfectant...**And more ACCs.**

	A	B	C	D	E	F	G		H	I	May Reduce If Either ...				
Month	Treated TOC (mg/L)	Source TOC (mg/L)	(1-A/B) x 100	Source Water Alkalinity (mg/L)	Required TOC Removal (%)	C/E Actual Removal Ratio	Credit 1.0 if **Paired Sample** Source or Treated TOC <2.0	Credit 1.0 if **RAA** Source or Treated TOC <2.0	Rem'l Ratio Qtly	Rem'l Ratio RAA	Source TOC Qtly Ave	Source TOC RAA	Treated TOC Qtly Ave	1 Yr Treated RAA <1.0	2 Yr Treated RAA <2.0	Compliance with Treatment Technique (TT)
														Rule 719e(4)(b)		
January 2015								#REF!								
February 2015	1.73	2.11	18.009	129	15	1.201	1.201	#REF!								
March 2015								#REF!	#REF!	#REF!	2.110	#REF!	1.730	#REF!	#REF!	#REF!
April 2015																
May 2015																
June 2015									M/R viol	#REF!		2.110		1.730	#REF!	Met ACC
July 2015																
August 2015																
September 2015									M/R viol	#REF!		2.110		1.730	#REF!	Met ACC
October 2015																
November 2015																
December 2015									M/R viol	#REF!		2.110		1.730	#REF!	Met ACC

APPENDIX C

C*T Calculations

BENTON HARBOR WATER TREATMENT PLANT
*C*T DETERMINATION*
May 2015

Basis of Assumptions

Worst case conditions were assumed to establish a conservative C*T estimate so that compliance with C*T standards would be assured under all other plant operating conditions. Those specific worst case parameters utilized were: minimum water temperature, maximum pH, minimum free chlorine residuals, maximum flow rates, and minimum volumes. A maximum plant flow of 12 MGD was used, even though the plant could only produce a maximum of 10 MGD with two of the filters out of service.

Source of Data

Chlorine residual and raw pH data were taken from the 2013 and 2014 Monthly Operation Reports (MORs). Flow rate remained at 12 MGD and a conservative cold water temperature of ½ ° C was used.

Total volumes for the settling basins, filters, and the finished water reservoir were taken from the Sanitary Survey Evaluation Form and are also shown on page 3 of this document. The settling basins and filters typically operate at or near maximum water levels, so no reductions in their volumes were required. Typically, the water level in the reservoir never drops below 8 feet. However, there have been rare occasions when the water level has dropped to 6.5 feet (half full). Therefore, 6.5 feet will be used in these calculations. The volume of the pipes within the treatment process, except the intake, were not included in the C*T calculations because detention times were very small.

At the Benton Harbor Water Treatment Plant, the pretreatment systems operate in parallel and there is no option for series operation.

The following worst case specific treatment parameters were obtained as described previously:

Table 1

Parameter	Value
Lowest Expected Temperature	<0.5 ^{0}C
Highest Recorded Plant Tap pH	7.9 (use 8.0 for Table E-1)
Lowest Intake Free Cl_2 Residual	Not Applying (do not count for C*T)
Lowest Mixing Chamber Free Cl_2 Residual	0.56 (use 0.6 Table E-1)
Lowest Settled Water Free Cl_2 Residual	0.84 mg/L (use 0.8 Table E-1)
Lowest Filtered Water Free Cl_2 Residual	0.73 mg/L (use 0.6 Table E-1)
Lowest Reservoir Water Free Cl_2 Residual	0.90 mg/L (use 0.8 Table E-1)

Note: Normal application points of chlorine is at the mixing chamber, and the high service pump discharge (after reservoir).

C*T is the product of the free chlorine residual present at the effluent of a given process and the " T_{10}" detention time. T_{10} is defined as the time at which 10 percent of the step input concentration of a conservative tracer is detectable at the effluent of a given process. No tracer studies have been completed to determine accurate T_{10} values. Until tracer studies are performed, T_{10} values must be estimated by multiplying the hydraulic detention time by a baffling factor. Conservative baffling factors were chosen based on EPA guidance materials for purposes of these calculations.

The overall surface water treatment requirement is 3-log (99.9%) removal/inactivation of *Giardia* and 4-log (99.99%) removal/inactivation of viruses. Conventional filtration treatment plants (coagulation, sedimentation, and filtration) are credited with 2.5-log removal of *Giardia* and 2-log removal of viruses. The remaining 0.5-log inactivation of *Giardia* and 2-log inactivation of viruses must be achieved by disinfection.

When free chlorine is the disinfectant, the C*T required for 0.5-log inactivation of *Giardia* becomes the limiting factor. Adequate C*T for 0.5-log *Giardia* inactivation will also provide more than 2-log inactivation of viruses.

The required C*T values for free chlorine @ 0.5 ^{0}C or lower were obtained from Table E-1 provided in U.S. EPA's "Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems using Surface Water Sources". A copy of Table E-1 is attached to this report. The required C*T values are dependent on temperature, pH, and free chlorine concentration.

The C*T calculations are summarized in the following table:

Table 2

Unit Process	Intake (1)	Floc Basins (2)	Settling Basins (2)	Filters (above media) (10/12)	Reservoir (1/2 vol.)	
Volume, V (Normal) (gallons)	208,742	336,600	269,280	130,526	1,000,000	
Flow, Q (MGD)	12	12	12	12	12	
Detention Time, T_H (minute) =V/Q	25	40	32	16	120	
Baffling Factor, B. F	1.0	0.7	0.5	1.0	0.3	
Effect. Det.Time,T_{10} (minute)=B.F * T_H	25	28	16	16	36	
pH	8.0	8.0	8.0	8.0	8.0	
Chlorine Residual, C_{eff} (mg/L)	0	0.6	0.8	0.6	0.8	
C*T Calculation= C_{eff}* T_{10}	0	16.8	12.9	9.6	28.8	
C*T Reqd. for 0.5 log Giardia Inactiva.	-	48	49	48	49	
C*T Reqd. for 1.0 log Giardia Inactiva.	-	95	98	95	98	
Log Inactivation	0.00	0.175	0.132	0.100	0.294	0.70 log

Volume Calculations and Baffle Assumptions

Intake – 3,950 ft x 0.785 (3 ft) ^{2} x 7.48 gal/ft^3 = 208,742 gals
Long length compared to small diameter approaches plug flow= 1.0

Flocculation basins - 168,300 gals each (per engineer)
Basins are run in parallel, and cannot be run in series.
Inlet/outlet baffles with paddle mixing = 0.7

Settling basins - 134,640 gals each (per engineer)
Basins are run in parallel, and cannot be run in series.
Inlet/outlet baffles and inclined plates to prevent short circuiting = 0.5

Filters – 349 ft^2 x 5 ft = 1745 ft^3 x 7.48 = 13,052 x 10 filters* = 130,526 gals
Square Shape but Media is an Excellent Baffle = 1.0
*2 filter cells share a common gullet, so 2 cells must be taken out of service at a time, thus 10 are operational during a backwash.

Reservoirs – 2 million gals total, half full (~ 6.5 ft deep) = 1 million gals
(100' x 100' x 6.5') x 7.48 = 486,200 gals x 2 ~ 1 MG
Separate Unbaffled Inlet & Baffled Outlet = 0.3

Conclusions

It appears that the Benton Harbor Water Treatment Plant as currently operated will meet C*T requirements under all conditions. Table 2 indicates that a cumulative 0.70 log inactivation of *Giardia* is provided under worst case conditions. This exceeds the required 0.5 log inactivation of *Giardia.*

The 0.70 log inactivation is less than the 1.50 log removal that was presented in the 2011 Sanitary Survey. The reasons for this difference are such;

> Chlorine residuals have been lowered as flow rates have diminished appreciably. The "worst case" shown in Table 2 uses flow rates that are unlikely unless there was a catastrophic emergency.
>
> The plant tap pH is slightly higher now that liquid chlorine is used than compared to the use of gas chlorine. The slight raise in pH (0.4-0.5 pH units) makes chlorine less effective.
>
> Intake chlorination has ceased as a matter of practice. Prior residuals in the shore well were 1.0 to 1.5 mg/l.

Another important requirement under the Surface Water Treatment Rule is the continuous monitoring of plant tap chlorine residual. The Benton Harbor Water Treatment Plant meets this requirement.

Current chlorination practices should be reviewed by plant staff. Familiarity with operational parameters such as chlorine dosages, seasonal water temperature, pH, basin depth and the influences these have on C*T are critical in assuring that the minimum C*T credit has been achieved. As long as the clarifier and filter effluent minimum chlorine residual is 0.4 mg/L or higher, and the finished water reservoir level does not drop below 6.5 feet, staff can be reasonably assured that the C*T requirements are being met. If the residual falls below 0.4 mg/L or the reservoir levels drop below 6.5 feet (or is taken out of service) specific calculations should be made to assure compliance.

More realistically, the water plant is run under typical conditions of a full reservoir, 2 filters out of service, one settling train, and much lower maximum day demands. 2.7 MGD max day is used in the following example. Table 3 approximates these conditions at conservatively low residuals and temperature;

Table 3

Unit Process	Intake (1)	Floc Basins (1)	Settling Basins (1)	Filters (above media) (8/10)	Reservoir (full)	
Volume, V (Normal) (gallons)	208,742	168,300	134,640	104,420	2,000,000	
Flow, Q (MGD)	2.7	2.7	2.7	2.7	2.7	
Detention Time, T_H (minute) =V/Q	111	90	72	56	1067	
Baffling Factor, B. F	1.0	0.7	0.5	1.0	0.3	
Effect. Det.Time,T_{10} (minute)=B.F * T_H	111	63	36	56	320	
pH	8.0	8.0	8.0	8.0	8.0	
Chlorine Residual, C_{eff} (mg/L)	0	0.6	0.8	0.6	0.8	
C*T Calculation = C_{eff}* T_{10}	0	37.8	28.8	33.6	256	
C*T Reqd. for 0.5 log Giardia Inactiva.	-	42	43	42	43	
C*T Reqd. for 1.0 log Giardia Inactiva.	-	84	86	84	86	
Log Inactivation	0.00	0.45	0.33	0.40	2.98	4.16 log

Even if one floc and settling basin was taken off line for cleaning during cold water temperatures (which is often the case), and treatment firm capacity of a single settling train to 7 MGD (an actual increase of rate through a single floc & settling basin), and the intake chlorine remaining off, the Benton Harbor water plant could still provide much more than 0.5 log inactivation.

Table 4

Unit Process	Intake (1)	Floc Basins (1)	Settling Basins (1)	Filters (above media) (8/10)	Reservoir (1/2 vol.)	
Volume, V (Normal) (gallons)	208,742	168,300	134,640	104,420	1,000,000	
Flow, Q (MGD)	7	7	7	7	7	
Detention Time, T_H (minute) =V/Q	43	35	28	21	206	
Baffling Factor, B. F	1.0	0.7	0.5	1.0	0.3	
Effect. Det.Time,T_{10} (minute)=B.F * T_H	43	24	14	21	62	
pH	8.0	8.0	8.0	8.0	8.0	
Chlorine Residual, C_{eff} (mg/L)	0	0.6	0.8	0.6	0.8	
C*T Calculation= C_{eff}* T_{10}	0	14.4	11.2	12.6	49.4	
C*T Reqd. for 0.5 log Giardia Inactiva.	-	42	43	43	42	
C*T Reqd. for 1.0 log Giardia Inactiva.	-	84	86	86	84	
Log Inactivation	0.00	0.17	0.13	0.15	0.59	1.04 log

TABLE E-1

CT VALUES FOR INACTIVATION

OF GIARDIA CYSTS BY FREE CHLORINE

AT 0.5 C OR LOWER (1)

CHLORINE CONCENTRATION (mg/L)	pH<=6 Log Inactivations						pH=6.5 Log Inactivations						pH=7.0 Log Inactivations						pH=7.5 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	23	46	69	91	114	137	27	54	82	109	136	163	33	65	98	130	163	195	40	79	119	158	198	237
0.6	24	47	71	94	118	141	28	56	84	112	140	168	33	67	100	133	167	200	40	80	120	159	199	239
0.8	24	48	73	97	121	145	29	57	86	115	143	172	34	68	103	137	171	205	41	82	123	164	205	246
1	25	49	74	99	123	148	29	59	88	117	147	176	35	70	105	140	175	210	42	84	127	169	211	253
1.2	25	51	76	101	127	152	30	60	90	120	150	180	36	72	108	143	179	215	43	86	130	173	216	259
1.4	26	52	78	103	129	155	31	61	92	123	153	184	37	74	111	147	184	221	44	89	133	177	222	266
1.6	26	52	79	105	131	157	32	63	95	126	158	189	38	75	113	151	188	226	46	91	137	182	228	273
1.8	27	54	81	108	135	162	32	64	97	129	161	193	39	77	116	154	193	231	47	(93)	140	186	233	279
2	28	55	83	110	138	165	33	66	99	131	164	197	39	79	118	157	197	236	48	95	143	191	238	286
2.2	28	56	85	113	141	169	34	67	101	134	168	201	40	81	121	161	202	242	50	99	149	198	248	297
2.4	29	57	86	115	143	172	34	68	103	137	171	205	41	82	124	165	206	247	50	99	149	199	248	298
2.6	29	58	88	117	146	175	35	70	105	139	174	209	42	84	126	168	210	252	51	101	152	203	253	304
2.8	30	59	89	119	148	178	36	71	107	142	178	213	43	86	129	171	214	257	52	103	155	207	258	310
3	30	60	91	121	151	181	36	72	109	145	181	217	44	87	131	174	218	261	53	105	158	211	263	316

CHLORINE CONCENTRATION (mg/L)	pH=8.0 Log Inactivations						pH=8.5 Log Inactivations						pH<=9.0 Log Inactivations					
	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0	0.5	1.0	1.5	2.0	2.5	3.0
<=0.4	46	92	139	185	231	277	55	110	165	219	274	329	65	130	195	260	325	390
0.6	48	95	143	191	238	286	57	114	171	228	285	342	68	136	204	271	339	407
0.8	49	98	148	197	246	295	59	118	177	236	295	354	70	141	211	281	352	422
1	51	101	152	203	253	304	61	122	183	243	304	365	73	146	219	291	364	437
1.2	52	104	157	209	261	313	63	125	188	251	313	376	75	150	226	301	376	451
1.4	54	107	161	214	268	321	65	129	194	258	323	387	77	155	232	309	387	464
1.6	55	110	165	219	274	329	66	132	199	265	331	397	80	159	239	318	398	477
1.8	56	113	169	225	282	338	68	136	204	271	339	407	82	163	245	326	408	489
(2)	(58)	115	173	231	288	346	70	139	209	278	348	417	83	167	250	333	417	500
2.2	59	118	177	235	294	353	71	142	213	284	355	426	85	170	256	341	426	511
2.4	60	120	181	241	301	361	73	145	218	290	363	435	87	174	261	348	435	522
2.6	61	123	184	245	307	368	74	148	222	296	370	444	89	178	267	355	444	533
2.8	63	125	188	250	313	375	75	151	226	301	377	452	91	181	272	362	453	543
3	64	127	191	255	318	382	77	153	230	307	383	460	92	184	276	368	460	552

Notes:

(1) $CT_{99.9}$ = CT for 3-log inactivation

APPENDIX D

Treatment Optimization Recommendations

STATE OF MICHIGAN

JOHN ENGLER, Governor

DEPARTMENT OF PUBLIC HEALTH

3423 N. MARTIN L. KING JR. BLVD.
P.O. BOX 30195, LANSING, MICHIGAN 48909
VERNICE DAVIS ANTHONY, MPH, Director

May 23, 1995

TO: Michigan Surface Water Treatment Plant Operators

Subject: Water Treatment Optimization Practices

Gentlemen/Ladies:

Several weeks ago U.S. EPA administrator Carol Browner outlined in a press conference a voluntary plan aimed at improving the overall effectiveness of surface water treatment facilities. The plan, called "The Partnership for Safe Water," is designed to encourage drinking water utilities to survey their facilities, treatment processes, operating and maintenance procedures, and management oversight practices to identify areas that will enhance the system's ability to prevent the entry of *Cryptosporidium, Giardia,* and other microbial contaminants to treated water. National partners include EPA, the Association of State Drinking Water Administrators, AWWA, the AWWA Research Foundation, the Association of Metropolitan Water Agencies, and the National Association of Water Companies.

In response to the outbreak of *Cryptosporidiosis* in Milwaukee, the Division of Water Supply has set forth practices for water utility officials to follow which should minimize the potential for such an event in Michigan. The attached recommended practices is the product of an ad hoc committee of Michigan water plant superintendents and others knowledgeable of complete water treatment operations. This document parallels in a somewhat condensed manner the goals of the EPA's national partnership plan which some Michigan communities have voluntarily agreed to participate in.

We urge that every surface water treatment plant superintendent and their staff critically examine their respective water treatment operations using the enclosed material as guidance. Should there be any questions about the recommended practices, please contact your district engineer.

Very truly yours,

James K. Cleland

James K. Cleland, P.E., Chief
Division of Water Supply
Bureau of Environmental and
Occupational Health

JKC:MKM
Enclosure

May 16, 1995

SUBJECT: Recommended Practices for Treatment Optimization

OVERVIEW

Increasing awareness of the potentially severe impact of cryptosporidium in drinking water has refocused attention on the importance of optimal water treatment. Because cryptosporidium is resistant to the disinfectants typically used in water treatment plants, it is essential that every effort be made to effect their removal through the pretreatment and filtration processes.

The department has utilized the input of a group of Michigan water treatment plant superintendents to develop recommended practices in four areas: treatment goals, monitoring protocols, treatment optimization, and emergency operating procedures. These treatment practices must be optimized if Michigan water supplies are to continue to avoid the cryptosporidiosis outbreaks experienced in other areas of the country.

TREATMENT GOALS

The goal of all water treatment plants should be to consistently produce finished water turbidities of 0.1 ntu or less.

The goal for each individual filter should be to consistently produce water with turbidities of 0.1 ntu or less.

The goal of plant operators should be to minimize the size and duration of turbidity increases above 0.1 ntu in individual filters after the following:

1) Restarting filters after backwash.
2) Restarting unwashed filters after routine plant shutdown.
3) Changes in filtration rates.
4) Changes in settled water quality.

MONITORING PROTOCOLS

Conformance with the treatment goals outlined above can only be determined if the necessary monitoring information is available. It is recommended that continuously recording turbidimeters be provided for:

1) Raw water.
2) Settled water.
3) Each individual filter.
4) Combined filter effluent.

Where it is not feasible to provide a turbidimeter for each filter, it is recommended that each group or bank of filters be provided with one turbidimeter and the necessary piping and valving to allow for monitoring of a specific filter or the entire group of filters.

It is recommended that particle counters be utilized to determine the effectiveness of optimized treatment. Particle counters have the potential to provide an earlier and more sensitive detection of water quality changes than turbidimeters. It is recommended that settled water and filtered water particle counts be monitored as another indicator of treatment efficiency and to provide a numerical measure of the removal of particles in the 2-5 micron cryptosporidium size range.

Because of the high cost and uncertain reliability of cryptosporidium and giardia testing, the State does not recommend routine testing for these parameters at this time. However, if improvements in methods and reductions in analytical costs occur, this type of monitoring will become useful in evaluating plant performance. Cryptosporidium and giardia testing is currently optional for water utilities and may be useful depending on specific conditions. Such testing may be required in the future by U.S. EPA regulation. The limitations of current laboratory methods can lead to uncertain or unreliable results. As such, utilities which pursue testing must carefully interpret these results. Careful selection of qualified laboratories is also an important factor when considering such testing.

TREATMENT OPTIMIZATION

There is an extensive amount of literature published on the subject of water treatment. A list of selected references pertaining to treatment optimization is attached. Based on a series of meetings with water treatment plant superintendents, a number of treatment practices were identified as being potentially important with regard to cryptosporidium removal, and in achieving the treatment goals listed above.

For coagulant feed control, the following practices should be examined:

1) Routine jar testing.
2) Use of streaming current detectors or other methods for controlling coagulant feed rates.
3) Optimization of the rapid mix and flocculation stages of treatment, including periods when backwash water is recycled.
4) Use of polymers.

The effectiveness of previous coagulant adjustments made in response to adverse changes in raw water quality caused by climatic and hydrologic events should be reviewed.

For filter operation, the following practices should be examined:

1) Filtering to waste following backwash.
2) Adding coagulant directly onto the filter influent following backwash, in the backwash water, or at the end of a backwash.
3) Allowing filters to set for a period of time following backwash before returning to service.
4) Ramping up the flow rate onto any filter being returned to service.
5) Minimizing sudden rate changes on the filters.

6) Comparing length of filter runs and head loss development with filter effluent turbidities.
7) Routine inspections for gravel mounding, mud balls, bed cracking, media growth, and media loss.
8) Checking for even flow distribution during backwash.

Many plants have been shown to operate more effectively from a water quality standpoint if the overall treatment rate is reduced. A reduction in the plant operating rate should be considered whenever monitoring shows degradation of treated water quality. Reductions in rates should also be considered during periods of adverse raw water quality or cold water conditions. It may be necessary to establish a lower overall plant rating than previously set in order to ensure meeting plant treatment goals at all times.

If reclaim of backwash water is part of routine plant operations, extreme care must be given to this practice to ensure against lowering plant effluent quality. Should there be any question about meeting treatment goals as the result of reclaim operations, discontinuing this practice permanently is encouraged.

EMERGENCY OPERATING PROCEDURES

All treatment plants occasionally experience changes in raw water quality that cause treatment goals to be exceeded. Experience has shown that brief periods of ineffective treatment can cause a cryptosporidiosis outbreak. Our discussions with water treatment plant superintendents emphasized the need to review in advance any procedures that may be effective in dealing with adverse changes in water quality. In particular, it was emphasized that information must be shared among operators in a treatment plant so that proper emergency procedures are implemented regardless of the operator on duty. It is recommended that each plant prepare a specific list of procedures for dealing with the various types of adverse treatment conditions that have previously been encountered. Plant staff are encouraged to review past operating history to evaluate the effectiveness of previous responses to these conditions so as to more quickly implement an effective treatment regime.

A number of emergency procedures were emphasized when treatment goals are being exceeded. They include:

1) Temporary plant shutdown.
2) Slowing treatment rates.
3) Stopping reclaim of backwash water.
4) Monitoring individual filter turbidities.
5) Filtering to waste.
6) Hand dosing of coagulant onto filters.
7) Use of anionic or non-ionic polymer filter aids.
8) Increasing disinfectant dose.
9) Increasing monitoring frequencies.

REFERENCES

The following recent articles and/or conferences focused on optimizing water treatment operations. It is strongly recommended that water plant officials review these article and conference outlines to help assess the overall performance of their plants and to better determine what areas of the overall operations and facilities need improvements or corrections.

1. "Assessing Treatment Plant Performance"; William D. Bellamy, John L. Cleasby, Gary S. Logsdon, and Martin J. Allen; Journal AWWA, Vol 85, December 1993, pp. 34-38.

2. "Preventing Waterborne Disease: How to Optimize Treatment", Participant Guide, AWWA Satellite Teleconference, September 9, 1994.

3. "Chicago, Bulls, and Cryptosporidium", AWWARF Technology Transfer Conference, Conference Outline, October 14, 1993.

Appendix E

Pertinent Correspondence

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
KALAMAZOO DISTRICT OFFICE

RICK SNYDER
GOVERNOR

DAN WYANT
DIRECTOR

February 9, 2015

Mr. Darwin Watson
City of Benton Harbor
200 Wall Street
Benton Harbor, MI 49022

VIOLATION NOTICE
WSSN: 0600

Dear Mr. Watson:

SUBJECT: Violation Notice – Maximum Contaminant Level (MCL) for Haloacetic Acids (HAA5s)

The Department of Environmental Quality, Office of Drinking Water and Municipal Assistance (ODWMA), records show that the city of Benton Harbor is in violation of the Safe Drinking Water Act 1976 PA 399, as amended (Act 399); R 325.10610, *MCLs for disinfection byproducts.*

In accordance with this rule, a water supply is in violation of the MCL for disinfection byproducts when the locational running annual average (LRAA) exceeds the MCLs for total trihalomethanes (TTHMs), and/or HAA5s, based on the results for the last four-quarter monitoring period. The MCLs for TTHMs and HAA5s are 0.080 mg/ L and 0.060 mg/L respectively. Our records show that the average level of HAA5s in the city of Benton Harbor water system was 0.064 mg/L for the compliance period of January 1, 2014, to December 31, 2014, which is a violation of the MCL. Our investigation consisted of a review of the ODWMA files for laboratory reports received for compliance monitoring.

Our investigation is considered complete. This violation began on October 1, 2014, and will continue until you return to compliance. To return to compliance, you must continue monitoring quarterly beginning the monitoring period January 1, 2015, to March 31, 2015, until results are reliably and consistently below the MCL.

Administrative rule R 325.10403 requires that suppliers provide public notice not later than 30 days after learning of the violation by mail or direct delivery and by any other means reasonably calculated to reach other persons regularly served by the system. Enclosed is a sample public notice. Please notify your consumers by **March 8, 2015**, and send us a signed and dated copy of the notice that was issued within 10 days of distributing the public notice. This violation must be included in your Consumer Confidence Report (CCR,) due by July 1, 2015.

Failure to issue a public notice for this violation may result in a fine of at least $1,000. Additional violations are subject to fines of increasing amounts. If you would like more information on the ODWMA policy on administrative fines policy, please contact me.

If you have any factual information you would like us to consider regarding the violation identified in this Notice, please provide it in a written response by **March 9, 2015**.

We anticipate and appreciate your cooperation in resolving this matter. If you have any questions regarding this Violation Notice, please contact me at the phone number below, or by e-mail at reyesk@michigan.gov.

Sincerely,

Katelyn Reyes
District Engineer
Kalamazoo District Office
Office of Drinking Water & Municipal Assistance
269-216-1691

KR:NE

Enclosure

cc: Mr. Stewart Beach, Water Plant Superintendent
Berrien County Health Department

RICK SNYDER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
KALAMAZOO DISTRICT OFFICE

DAN WYANT
DIRECTOR

June 18, 2014

Mr. Darwin Watson
City of Benton Harbor
200 East Wall Street
Benton Harbor, Michigan 49002

WSSN: 0600

Dear Mr. Watson:

SUBJECT: Stage 2 Disinfection Byproduct Rule (DBPR) Operational Evaluation Level (OEL) Exceedance

The Department of Environmental Quality (DEQ), Office of Drinking Water and Municipal Assistance (ODWMA), records show that the city of Benton Harbor (City) has exceeded the compliance levels for disinfection byproducts prescribed by R325.107191 of the Safe Drinking Water Act, 1976 PA 399, as amended (Act 399).

In accordance with this rule, a community water supply that is monitoring under the Stage 2 DBPR has exceeded the OEL when the sum of the two previous quarters, plus twice the current quarter's result, divided by four to determine the average, exceeds 0.080 mg/L for Total Trihalomethanes (TTHM) or 0.060 mg/L for Haloacetic Acids (HAA5). Below are tables that list the TTHM and HAA5 results for the City, including the most recent quarterly results:

TTHM Data

Stage 2 DBPR Location	November	February	May	Operational Evaluation Value:
	A	B	C	D= (A+B+(2*C))/4
DBP1 (mg/L)	0.0276	0.0326	0.0252	0.02765
DBP2 (mg/L)	0.0318	0.035	0.0259	0.02965

HAA5 Data

Stage 2 DBPR Location	November	February	May	Operational Evaluation Value:
	A	B	C	D= (A+B+(2*C))/4
DBP1 (mg/L)	0.001	0.037	0.139	0.079
DBP2 (mg/L)	0.023	0.035	0.015	0.022

Based on the calculations shown above, the City's Stage 2 sampling location DBP1 is in exceedance of the OEL for HAA5. The City shall conduct an operational evaluation and submit the report within 90 days of receiving this notification. The evaluation shall include information on the operational practices of the system's treatment and distribution, including the storage tank operations, excess storage capacity, and distribution system flushing. The system shall also review any changes in the water source or source water quality, treatment changes, and finished water quality, and analyze any other problems that may contribute to the formation of TTHM and HAA5. After this evaluation, the system will provide a report to our office describing their findings and future actions that could be considered to minimize future exceedances. The evaluation report must also be made available to the public upon request.

Enclosed is the Operational Evaluation Reporting Form that can assist in the collection of the necessary information in order to complete your Operational Evaluation Report. This document is only meant to be a guideline and the actual Operational Evaluation Report for the City must contain detailed information regarding the analysis of the system, and the location and cause of the OEL exceedance.

Failure to complete the operational evaluation within the 90 day time frame will result in a violation and the supply will need to distribute a public notice to all its customers.

We anticipate and appreciate your cooperation in completing this evaluation. If you have any questions regarding this letter, please contact me at the telephone number below or by email at pomavillek@michigan.gov.

Sincerely,

Katelyn Pomaville

Katelyn Pomaville
Kalamazoo District Office
Office of Drinking Water and Municipal Assistance
269-567-3612

Enclosure

cc/enc: Mr. Stewart Beach, City of Benton Harbor

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

RICK SNYDER
GOVERNOR

DAN WYANT
DIRECTOR

GAW

0600. corr.

January 6, 2014

Mr. Darwin Watson, Interim City Manager
City of Benton Harbor
200 East Wall Street
Benton Harbor, Michigan 49022

Dear Mr. Watson:

SUBJECT: Drinking Water Revolving Fund (DWRF)
City of Benton Harbor
DWRF Project No. 7262-01

We are pleased to inform you that the above-referenced project is administratively complete. Final Disbursement Request No. 18 identified overdrawn funds in the amount of $6,972.00 for which repayment was received on November 21, 2013. The revised project loan amount is $1,332,003.00. If you have not already received a recalculated repayment schedule, the Michigan Finance Authority (MFA) will forward a new schedule to you that reflects the final amount of the DWRF loan.

As your final loan amount is less than the Order of Approval amount, MFA will send a confirmation letter for any adjusted principal amount with accrued interest from this letter date that had been previously forgiven. Inasmuch as this project received assistance from the American Recovery and Reinvestment Act of 2009, the amount of principal forgiveness has been adjusted to 40 percent of the revised final loan amount consistent with the following:

Total Loan Amount:	ARRA Funded Amount:	Amount of Principal Forgiven:
$1,332,003.00	$1,238,800.00	$532,801.00

Please note that the MFA or the Michigan Department of Environmental Quality (DEQ) may conduct an audit or other review of your project to determine whether DWRF program requirements have been met. You will be notified in advance of any on-site review. Please retain all project records, whether in written or computerized form, for three years from the date of this letter. If requested, you must provide such records to the MFA, the DEQ, or their agents for inspection.

We are pleased that we could assist you in your effort to improve your drinking water system. If you have any questions regarding this project, please contact Mr. Clarence Jones, Project Manager, Revolving Loan Section, Office of Drinking Water and Municipal Assistance, by phone at 517-284-5410; or by mail at DEQ, P.O. Box 30241, Lansing, Michigan 48909-7741; or you may contact me.

RECEIVED
MICH. DEPT. OF NATURAL RESOURCES AND ENVIRONMENT
JAN 13 2014
ENVIRONMENTAL RESOURCE MANAGEMENT DIVISION
KALAMAZOO DISTRICT OFFICE

Sincerely,

Sonya T. Butler, Chief
Revolving Loan Section
Office of Drinking Water and Municipal Assistance
517-284-5433

cc: Mr. Kenton McAndrew, Abonmarche Group, Benton Harbor
Ms. Nichole Dorr, MFA
Mr. Gary Wozniak, DEQ-ODWMA, Kalamazoo District Office
Ms. Debbie Martinson, DEQ

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

RICK SNYDER
GOVERNOR

DAN WYANT
DIRECTOR

0600

September 25, 2013

RECEIVED
MICH. DEPT. OF NATURAL RESOURCES AND ENVIRONMENT
OCT 01 2013
ENVIRONMENTAL RESOURCE MANAGEMENT DIVISION
KALAMAZOO DISTRICT OFFICE

Mr. Darwin Watson, Interim City Manager
City of Benton Harbor
200 East Wall Street
Benton Harbor, Michigan 49022

Dear Mr. Watson:

SUBJECT: Drinking Water Revolving Fund (DWRF)
City of Benton Harbor
DWRF Project No. 7273-01

We are pleased to inform you that your final Disbursement Request No. 22, in the amount of $131,324, was paid on May 3, 2012. Your project is now administratively complete.

Inasmuch as this project received assistance from the American Recovery and Reinvestment Act of 2009, the amount of principal forgiveness is 40 percent of the final loan amount consistent with the following:

Total Loan Amount:	ARRA Funded Amount:	Amount of Principal Forgiven:
$14,370,000	$5,748,000	$5,748,000

Please note that the MFA or the Michigan Department of Environmental Quality (DEQ) may conduct an audit or other review of your project to determine whether DWRF program requirements have been met. You will be notified in advance of any on-site review. Please retain all project records, whether in written or computerized form, for three years from the date of this letter. If requested, you must provide such records to the MFA, the DEQ, or their agents for inspection.

We are pleased that we could assist you in your effort to improve your drinking water system. If you have any questions regarding this project, please contact Mr. Clarence Jones, Project Manager, Revolving Loan Section, Office of Drinking Water and Municipal Assistance, by phone at 517-284-5410; or by mail at DEQ, P.O. Box 30241, Lansing, Michigan 48909-7741; or you may contact me.

Sincerely,

Sonya T. Butler, Chief
Revolving Loan Section
Office of Drinking Water and Municipal Assistance
517-284-5433

cc: Mr. Kenton McAndrew, Abonmarche Group – Benton Harbor
Ms. Nichole Dorr, MFA
Mr. Gary Wozniak, DEQ- ODWMA, Kalamazoo District Office
Ms. Debbie Martinson, DEQ

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

RICK SNYDER
GOVERNOR

DAN WYANT
DIRECTOR

August 29, 2013

Mr. Tony Saunders
City of Benton Harbor
200 East Wall Street
Benton Harbor, Michigan 49022

WSSN: 00600
City of Benton Harbor

Dear Mr. Saunders:

SUBJECT: Stage 2 DDBP Monitoring Plan Approval

The City of Benton Harbor's Stage 2 Disinfectants and Disinfection Byproduct (DDBP) Monitoring Plan submitted on August 22, 2013, was received and approved by this office. Please conduct monitoring in accordance with your Stage 2 DDBP Monitoring Plan as summarized below.

Monitor during the month(s) of August at the following locations:

Sample For	Site Code	Address of Sample Site	Frequency
☒ TTHM ☒ HAA5	DBP1	Bluewater Thermal (S. Fair and Valley Drive)	Quarterly
☒ TTHM ☒ HAA5	DBP2	B&Z Construction Milton St.	Quarterly

The Stage 2 DDBP monitoring plan will be shown in your 2014 Monitoring Schedule that will be sent to you at the beginning of next year. Stage 2 will go into effect on October 1, 2013; therefore your next monitoring period will be during November 2013.

If you use a private laboratory, report the results to this office by the 10th of the month following the month in which results are received. Be sure to include WSSN and Site Code when submitting your results to ensure you receive proper credit for monitoring.

If you have questions, please contact me by phone at 269-567-3612 or by email at pomavillek@michigan.gov.

Sincerely,

Katelyn Pomaville

Katelyn Pomaville
Kalamazoo District Office
Office of Drinking Water and Municipal Assistance

KP:CWD

cc: Mr. Stewart Beach, Water Plant Superintendent

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

RICK SNYDER
GOVERNOR

DAN WYANT
DIRECTOR

March 8, 2012

Mr. Joseph Harris, Emergency Financial Manager
City of Benton Harbor
200 East Wall Street
Benton Harbor, Michigan 49022

WSSN: 0600

Dear Mr. Harris:

SUBJECT: 2011 Drinking Water Sanitary Survey

Enclosed is a copy of our Sanitary Survey Report (Report) evaluating the City of Benton Harbor (City) water system with respect to the Michigan Safe Drinking Water Act, 1976 PA 399, as amended (Act 399); and the rules promulgated thereunder.

We want to recognize the effort and improvements the City has made since the previous Sanitary Survey in 2007, especially in the area of water treatment. The water plant improvements are impressive and should serve the City well for years to come. The 2007 Survey was also a Violation Notice and the City took great efforts to obtain funding and resolve the violations regarding water treatment quality and standby power.

Several distribution issues remain however, the most serious being; system mapping, valve and hydrant maintenance, and development of emergency inter-agreements with nearby water supplies. Please refer to the body of the report for specific requirements and recommendations in this regard. Because of the outstanding distribution issues, we find the City water system as **marginal** in rating.

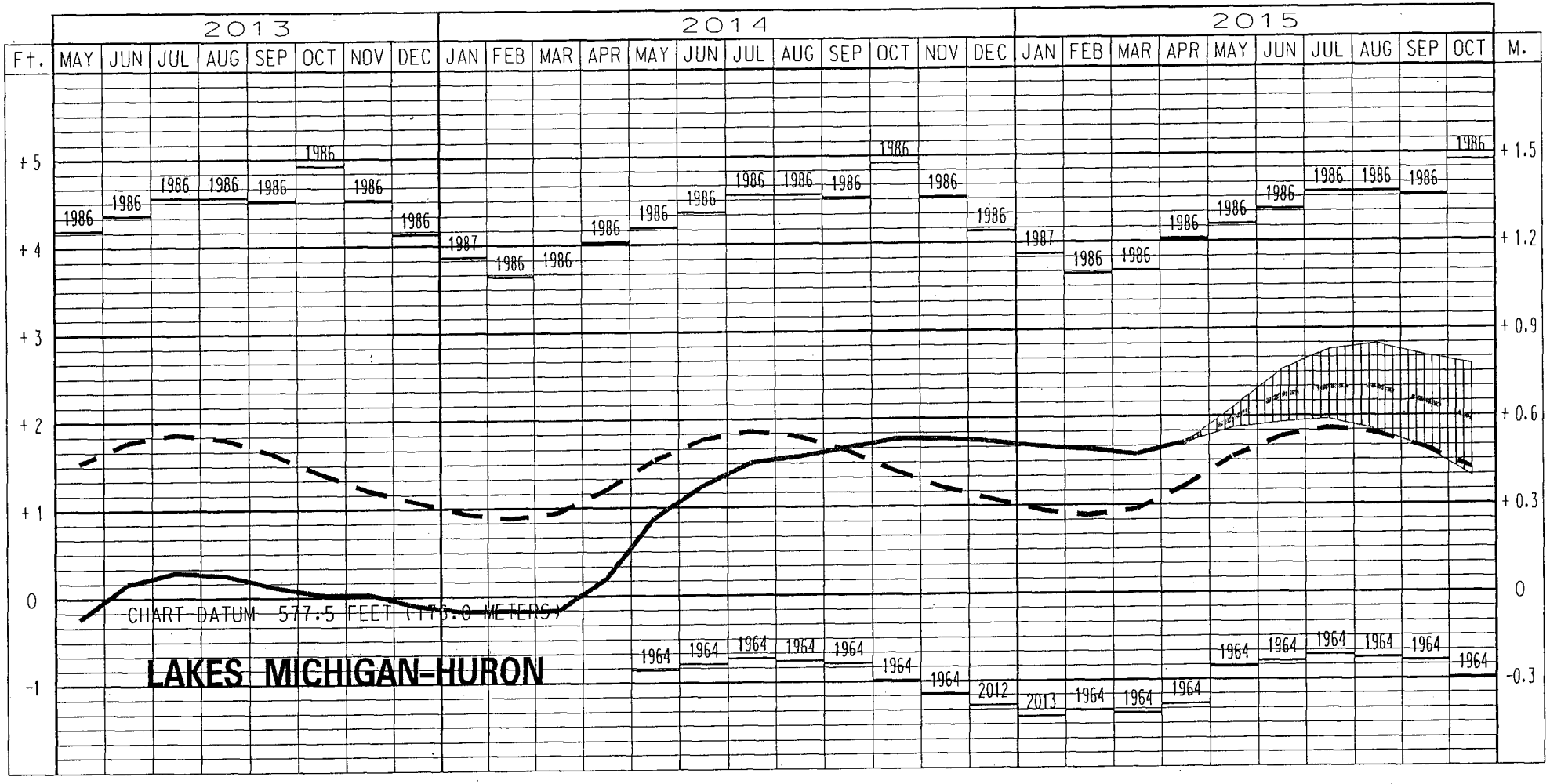
Resolution of the above distribution issues will result in a satisfactory rating. If you have any questions, please contact me at the number listed below or by mail at the DEQ, 7953 Adobe Road, Kalamazoo, Michigan 49009.

Sincerely,

Gary A. Wozniak, P.E., District Engineer
Field Operations Section
Resource Management Division
Kalamazoo District Office
269-567-3613

GAW:CWD
Enclosure
cc: Berrien County Health Department
Mr. Ronald Griffin, Supervisor, St. Joseph Charter Township
cc/enc: Ms. Debra L. Popp, Acting City Manager, City of Benton Harbor
Mr. Darwin Watson, Director of Utilities, City of Benton Harbor
Mr. Michael O'Malley, Water Superintendent, City of Benton Harbor
Mr. Tom Spitzner, Water/Sewer Superintendent, City of Benton Harbor
Mr. Kenton McAndrew, P.E., Abonmarche Consultants, Inc.

LAKES MICHIGAN–HURON WATER LEVELS – MAY 2015

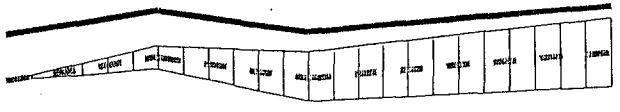


LEGEND

LAKE LEVELS

RECORDED

PROJECTED



AVERAGE **				
MAXIMUM **	1985	1985	1973	1973
MINIMUM **	1936	1934	1926	1934

** Average, Maximum and Minimum for period 1918-2014

BENTON - HARBOR
PORT OF OPPORTUNITIES

INSPECTION FORM

Facility

Address

City ST Zip

Main Contact Phone

Facility Type Inspection Date

Inspection Frequency yrs Completed? In Compliance?

Containment

	No. of Inlets	Protection Required	Properly Installed
Potable Supply			
Fire Supply			

	Exist
Secondary Sources	

Isolation Hazards

	Exist	Qty	Prply Protd		Exist	Qty	Prply Protd
1. Lawn Sprinkler(s)				7.			
2. Boiler(s)				8.			
3. Cooling Tower(s)				9.			
4. Heat Exchanger(s)				10.			
5. Water Cooled A/C				11.			
6. Temporary Machines				12.			

Remarks

Inspector's Name

Inspector's Signature

Contact's Signature

CHEMICAL FEED CALCULATIONS FOR WATER FILTRATION PLANT CITY OF BENTON HARBOR

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
PERMIT NO. W095080 OCT 26 '09
EXAMINED AND APPROVED FOR COMPLIANCE WITH ACT 399, P.A. 1976

Updated – August 18, 2009
Prepared By – Rick Smigielski, Abonmarche Consultants, Inc

I. Givens

Minimum Daily Flow – 400,000 gpd (2,778 gpm)
Average Design Flow – 12,000,000 gpd (8,333 gpm)
Maximum (Peak) Design Flow – 14,000,000 gpd (9,722 gpm)

II Low Service Pump Capacities

Number 1 – 1388 gpm
Number 2 – 2083 gpm
Number 3 – 3472 gpm
Number 4 – 2777 gpm
Number 5 - 4167 gpm

III. Chlorine Gas

A. Usage
Based on an average of 2.7 mg/l pre-treatment and 0.2 mg/l post-treatment = total say 3.0 mg/l
@ Minimum Daily flow – 10 pounds per day
@ Average Design flow - 300 pounds per day
@ Maximum Design flow - 350 pounds per day

B. Monthly usage
Average is about 400 pounds
One 2000-pound container in operation and one for standby

C. Feed Points
At the Lake Michigan intake
Low Service Pump Discharge pipe
Post Rapid Mix
Pre Filtration
Post Filtration
Plant Clear Well

D. Proposed Equipment
Scales – 2000 pound container with auto switchover
Chlorinators – one for each feed point

Chlorinators –
feed point chlorinators

- Lake Michigan Intake – 0 to 500 ppd
- Lowe service pump discharge pipe – 0 to 250 ppd
- Post rapid mix – 0 to 250 ppd
- Pre-filtration – 0 to 500 ppd
- Post filtration – 0 to 250 ppd
- Pre HSP suction well – 0 to 250 ppd

Ejector – One for each feed point, rated the same in ppd @ 70 psi backpressure
Diffuser / Check valve -

IV. Fluoride

A. Storage:
5,700 gallon bulk storage tank
Transfer pump – one at 56 gpm @ 56 TDH

B. Usage:
Liquid fluorosilicic acid at 23% solution.
Injection varies – 0.6 to 1.3 mg/l
@ Minimum daily flow – 20.0 pounds per day at 0.6 mg/l as F
43.4 pounds per day at 1.3 mg/l as F
@ Average design flow - 90.0 pounds per day at 0.9 mg/l as F
@ Maximum design flow - 105 pounds per day at 0.9 mg/l as F

B. Solution Feed
@ Minimum daily flow – 10.4 gallons solution per day at 0.6 mg/l
22.4 gallons solution per day at 1.3 mg/l
@ Average design flow - 47 gallons solution per day at 0.9 mg/l
@ Maximum design flow – 55 gallons solution per day at 0.9 mg/l

C. Monthly usage
Current average is about 704 gallons of solution per month (6 MGD @ 0.9 mg/l)

Proposed Equipment:
Delivered to site – bulk by tanker truck
Day tank – one at 100 gallons
Scale – one for day tank
Capacity – 2,000 pounds
Readout – digital
Accuracy – must be able to read to 0.1 pound

Fluoride Feed Pumps – Three Peristaltic positive displacement pumps
Control of the feed pump – interlock with the influent raw water flow meters 4-20 mA for a flow proportional feed rate control.

Dosage rates and feed pump sizing:

Fluoride solution feed requirement @ 4 MGD = 0.02 gpm
Fluoride solution feed requirement @ 6 MGD = 0.03 gpm
Fluoride solution feed requirement @ 12 MGD = 0.06 gpm
Fluoride solution feed requirement @ 14 MGD = 0.07 gpm

Recommended metering pump = 0 to 2.3 gph

V. Alum

A. Storage
Liquid aluminum sulfate (alum)
Two existing bulk storage tanks each at 3,800 gallons
One new bulk storage tank at 1,000 gallons
Total Proposed storage – 8,600 gallons
Transfer feed pumps – Two Thompson Mag pumps – 25 gpm @ 20' TDH (3/4 Hp)

B. Feed Rates
Injection varies – 1.7 to 3.0 mg/l solution (average is 2.4 mg/l)

Solution Feed
@ Minimum daily flow – 57 gallons per day at 1.7 mg/l
100 gallons per day at 3.0 mg/l
@ Average design flow – 240 gallons per day at 2.4 mg/l
@ Maximum design flow – 280 gallons per day at 2.4 mg/l

C. Monthly usage
Current average is about 3,600 gallons of solution per month (6 MGD @ 2.4 mg/l)

Proposed Equipment:
Aluminum Sulfate $Al_2(SO_4)_3$ solution delivered to site in 4,000 – 5,000 gallon tanker trucks
Day tank – one at 300 gallons
Scale – one for day tank
Capacity – 3,000 pounds
Readout – digital
Accuracy – must be able to read to 0.1 pound

Alum Feed Pumps – Peristaltic positive displacement metering pumps
Control of the feed pumps –Flow proportional interlock with the influent flow meter 4-20 summarized mA control signal.

Dosage rates and pump sizing:

2.4 mg/l Alum solution feed requirement @ 4 MGD = 3.3 gph
2.4 mg/l Alum solution feed requirement @ 6 MGD = 5.0 gph
2.4 mg/l Alum solution feed requirement @ 12 MGD = 10.0 gph
2.4 mg/l Alum solution feed requirement @ 14 MGD = 11.7 gph

Size pump to go from 0.0 gph to 10.0 gph

END

1170 RPM ENCLOSED TYPE IMPELLER 14EKM

NUMBER OF STAGES	EFFICIENCY CHANGE (NO. OF POINTS)
1	-2
2	-1
3	-0

HORSEPOWER WILL BE AFFECTED BY CHANGE IN EFFICIENCY

PUMP DATA

Shaft Dia.(IN)	1 15/16
Maximum Sphere (IN)	3/4
Maximum Head (FT)*	1090
Min. Submergence (IN)**	20
Impeller Weight (LBS)	24
Thrust Constant (K)	12.5
Thrust Bal Const. (K)	9.6
Bowl O.D.(IN.)	13 3/4
Bowl Height (IN.)	9 7/8
Bell DIA. (T) (IN.)	13 1/16
Strainer height (IN.)	10 3/4
Impeller C-line (X)(IN.)	9
Eye Area (IN^2)	25

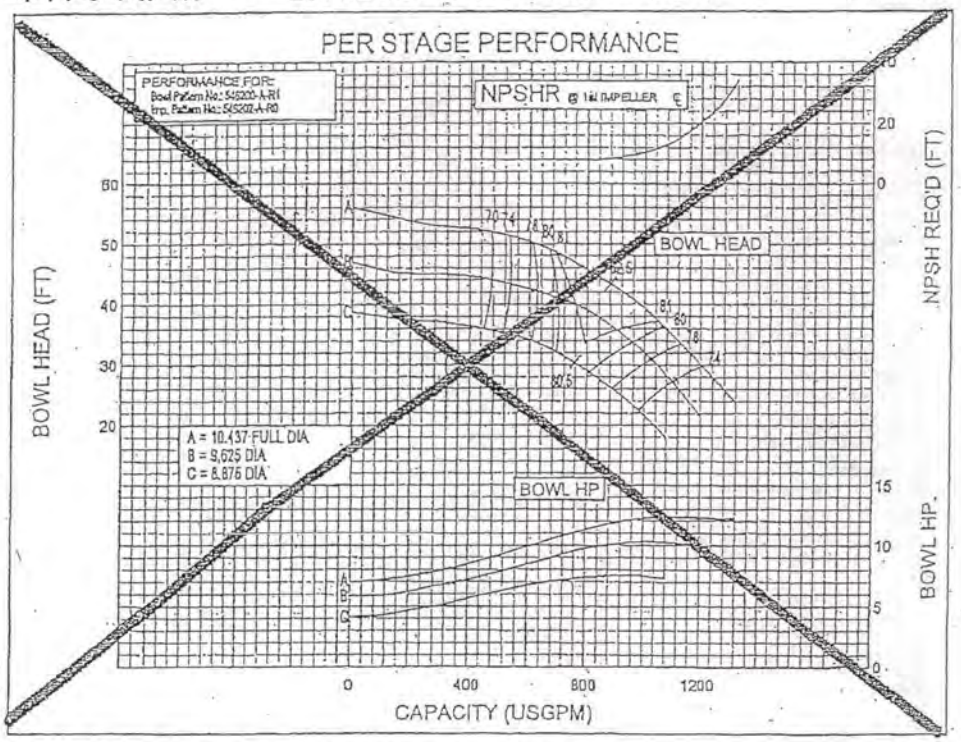
NOTES

Performance indicated based on cold water with a pacific gravity of 1.0.

* Standard Construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.



CITY OF BENTON HARBOR WET WELL DRAIN PUMP

1000 GPM AT 32' TDH

1170 RPM SEMI-OPEN TYPE IMPELLER 14DOL

NUMBER OF STAGES	EFFICIENCY CHANGE (NO. OF POINTS)
1	-3
2	-2
3	-1

HORSEPOWER WILL BE AFFECTED BY CHANGE IN EFFICIENCY

PUMP DATA

Shaft Dia.(IN)	1 15/16
Maximum Sphere (IN)	1 1/2
Maximum Head (FT)*	767
Min. Submergence (IN)**	24
Impeller Weight (LBS)	16
Thrust Constant (K)	20.3
Thrust Bal Const. (K)	N/A
Bowl O.D.(IN.)	13 1/8
Bowl Height (IN.)	12
Bell DIA.(T) (IN.)	13 1/16
Strainer height (IN.)	10 3/4
Impeller C-line(X)(IN.)	9 1/2
Eye Area (IN^2)	36.2

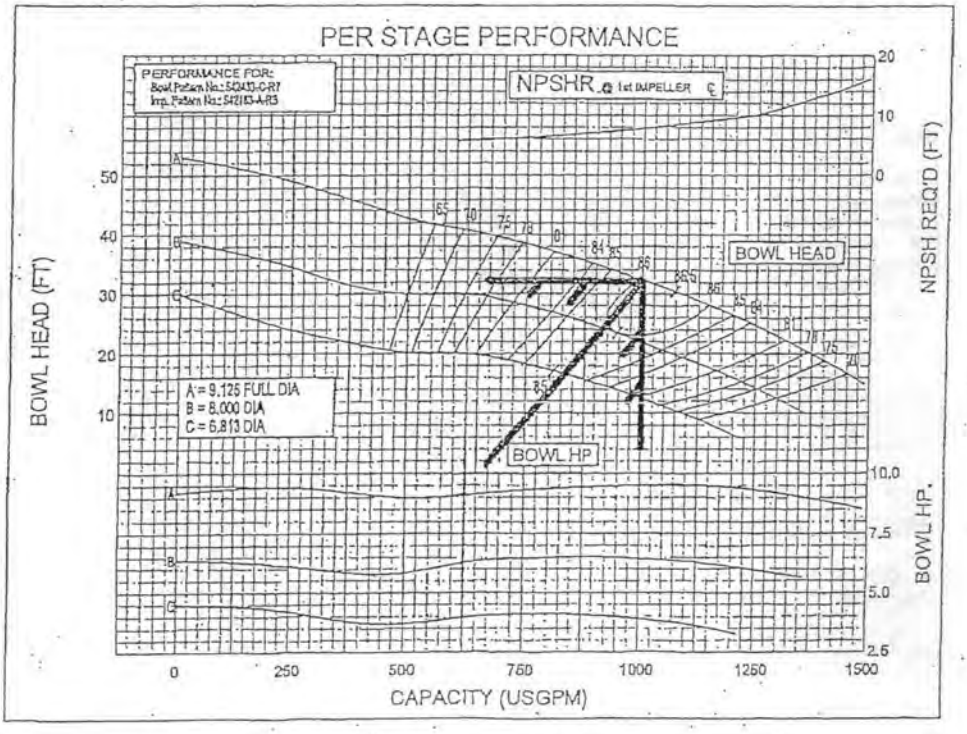
NOTES

Performance indicated based on cold water with specific gravity of 1.0.

* Standard Construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.



~~1770 RPM ENCLOSED TYPE IMPELLER 15DKH~~

NUMBER OF STAGES	EFFICIENCY CHANGE (NO. OF POINTS)
1	- 2
2	- 1
3	- 0

HORSEPOWER WILL BE AFFECTED BY CHANGE IN EFFICIENCY

PUMP DATA

Shaft Dia.(IN)	2 1/4
Maximum Sphere (IN)	1 1/4
Maximum Head (FT)*	698
Min. Submergence (IN)**	32
Impeller Weight (LBS)	28.3
Thrust Constant (K)	17.5
Thrust Bal Const. (K)	0
Bowl O.D.(IN.)	14 7/8
Bowl Height (IN.)	13 1/2
Bell DIA. (T) (IN.)	15
Strainer height (IN.)	10
Impeller C-line(X)(IN.)	7
Eye Area (IN^ 2)	43.4

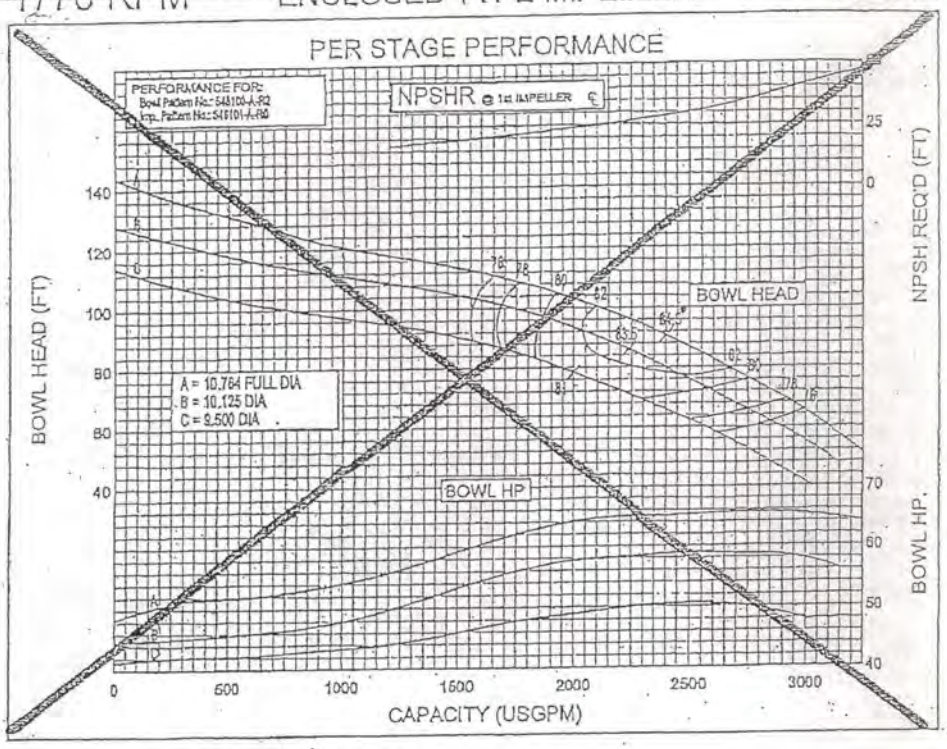
NOTES

Performance indicated based on cold water with specific gravity of 1.0.

* Standard Construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.



CITY OF BENTON HARBOR #2 HIGH SERVICE
2980 GPM AT 200' TDH 2 STAGES

1770 RPM ENCLOSED TYPE IMPELLER 15DKH

NUMBER OF STAGES	EFFICIENCY CHANGE (NO. OF POINTS)
1	- 2
2	- 1
3	- 0

HORSEPOWER WILL BE AFFECTED BY CHANGE IN EFFICIENCY

PUMP DATA

Shaft Dia.(IN)	2 1/4
Maximum Sphere (IN)	1 1/4
Maximum Head (FT)*	698
Min. Submergence (IN)**	32
Impeller Weight (LBS)	30.7
Thrust Constant (K)	17.3
Thrust Bal Const. (K)	0
Bowl O.D.(IN.)	14 7/8
Bowl Height (IN.)	13 1/2
Bell DIA. (T) (IN.)	15
Strainer height (IN.)	10
Impeller C-line(X)(IN.)	7
Eye Area (IN^ 2)	43.4

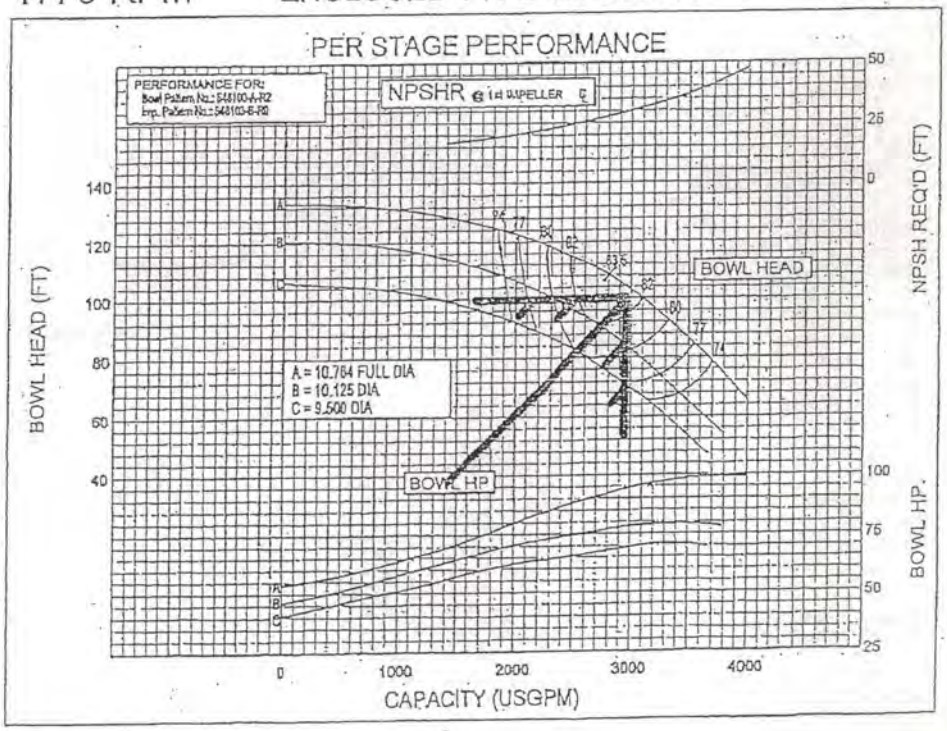
NOTES

Performance indicated based on cold water with specific gravity of 1.0.

* Standard Construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.



CITY OF BENTON HARBOR #1 HIGH SERVICE PUMP
9/1/01 1410 GPM AT 200' TDH 3 STAGES

1770 RPM ENCLOSED TYPE IMPELLER 14DKL

NUMBER OF STAGES	EFFICIENCY CHANGE (NO. OF POINTS)
1	- 3
2	- 1
3	- 0

HORSEPOWER WILL BE AFFECTED BY CHANGE IN EFFICIENCY

PUMP DATA

Shaft Dia.(IN)	1 15/16
Maximum Sphere (IN)	1
Maximum Head (FT)*	767
Min. Submergence (IN)**	24
Impeller Weight (LBS)	25.5
Thrust Constant (K)	16.5
Thrust Bal Const. (K)	N/A
Bowl O.D.(IN.)	13 5/16
Bowl Height (IN.)	12
Bell DIA. (T) (IN.)	13 1/16
Strainer height (IN.)	10 3/4
Impeller C-line(X)(IN.)	9 1/2
Eye Area (IN^2)	36.2

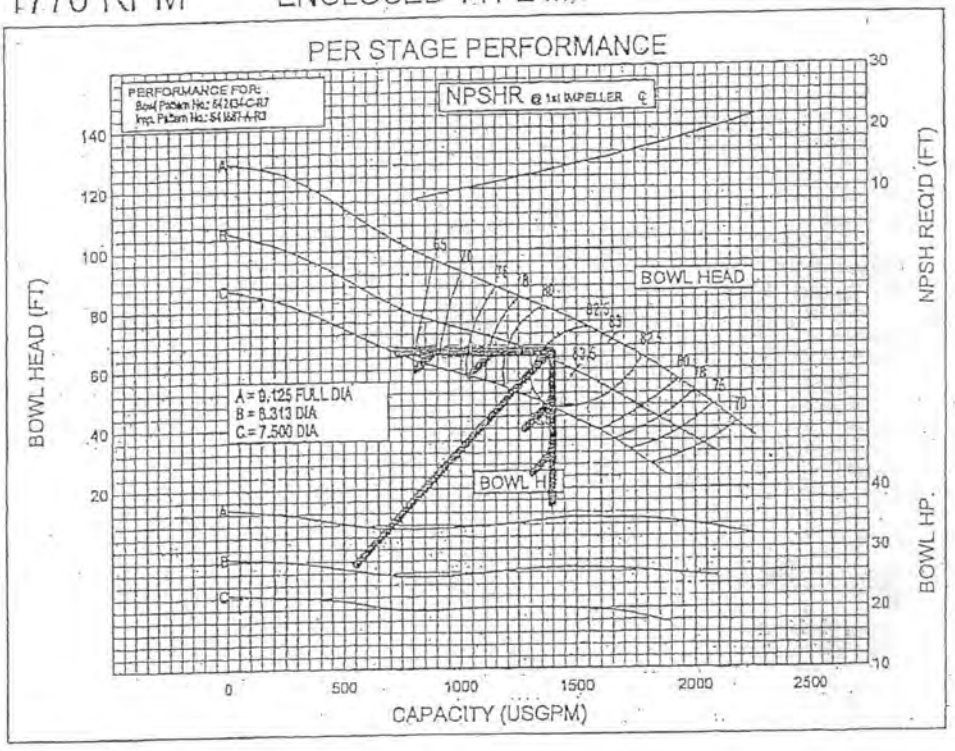
NOTES

Performance indicated based on cold water with specific gravity of 1.0.

* Standard Construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.



~~1770 RPM ENCLOSED TYPE IMPELLER 14DKM~~

NUMBER OF STAGES	EFFICIENCY CHANGE (NO. OF POINTS)
1	- 3
2	- 1
3	- 0

HORSEPOWER WILL BE AFFECTED BY CHANGE IN EFFICIENCY

PUMP DATA

Shaft Dia.(IN)	1 15/16
Maximum Sphere (IN)	1 1/4
Maximum Head (FT)*	767
Min. Submergence (IN)**	24
Impeller Weight (LBS)	25.9
Thrust Constant (K)	16.5
Thrust Bal Const. (K)	N/A
Bowl O.D.(IN.)	13 5/16
Bowl Height (IN.)	12
Bell DIA. (T) (IN.)	13 1/16
Strainer height (IN.)	10 3/4
Impeller C-line(X)(IN.)	9 1/2
Eye Area (IN^2)	36.2

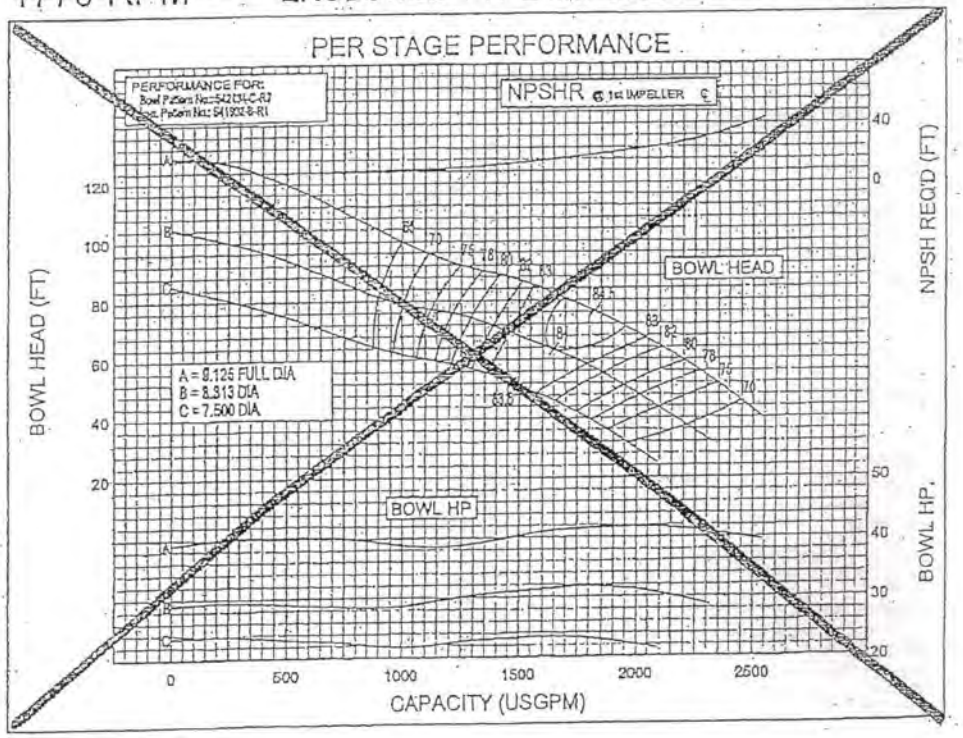
NOTES

Performance indicated based on cold water with specific gravity of 1.0.

* Standard Construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.



~~1180 RPM ENCLOSED TYPE IMPELLER 24XKN~~

NUMBER OF STAGES	EFFICIENCY CHANGE (NO. OF POINTS)
1	
2	
3	

HORSEPOWER WILL BE AFFECTED BY CHANGE IN EFFICIENCY

PUMP DATA

Shaft Dia.(IN)	
Maximum Sphere (IN)	
Maximum Head (FT)*	
Min. Submergence (IN)**	
Impeller Weight (LBS)	
Thrust Constant (K)	
Thrust Bal Const. (K)	
Bowl O.D.(IN.)	
Bowl Height (IN.)	
Ball DIA. (T) (IN.)	
Strainer height (IN.)	
Impeller C-line(X)(IN.)	
Eye Area (IN^ 2)	

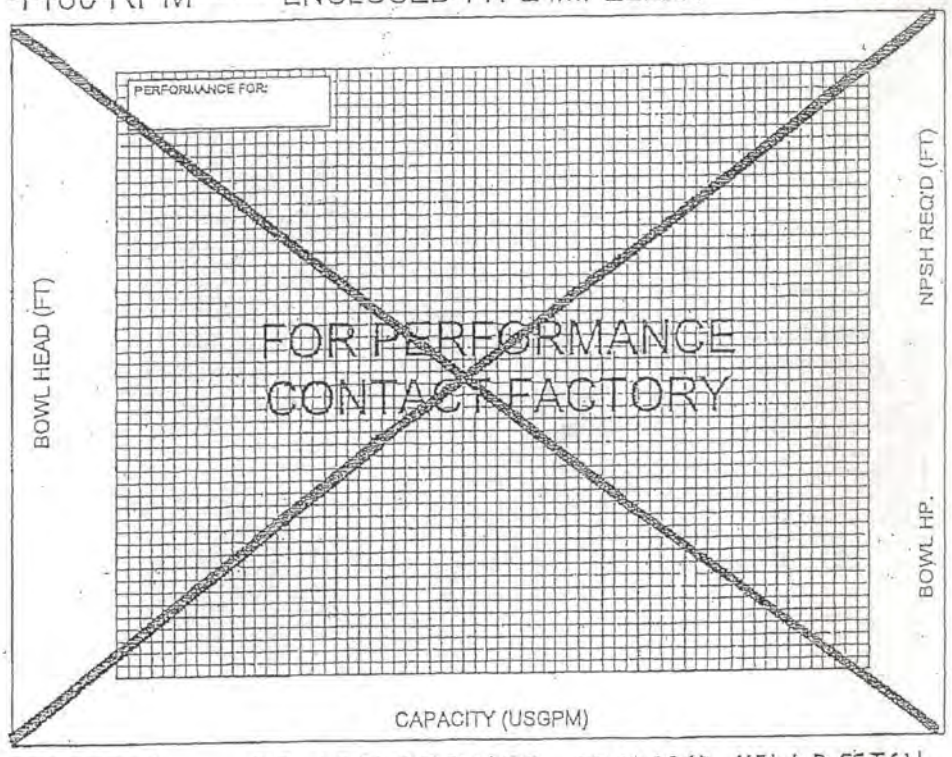
NOTES

Performance indicated based on cold water with specific gravity of 1.0.

* Standard Construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.



CITY OF BENTON HARBOR #5 LOW SERVICE PROPOSED NEW DESIGN
4160 GPM AT 56' TDH

1180 RPM ENCLOSED TYPE IMPELLER 22BKL-S

NUMBER OF STAGES	EFFICIENCY CHANGE (NO. OF POINTS)
1	See Note
2	- 0
3	- 0

HORSEPOWER WILL BE AFFECTED BY CHANGE IN EFFICIENCY

PUMP DATA

Shaft Dia.(IN)	2 7/16
Maximum Sphere (IN)	1 1/2
Maximum Head (FT)*	60.1
Min. Submergence (IN)**	48
Impeller Weight (LBS)	81.8
Thrust Constant (K)	40
Thrust Bal Const. (K)	N/A
Bowl O.D.(IN.)	21
Bowl Height (IN.)	17 1/2
Ball DIA. (T) (IN.)	26
Strainer height (IN.)	12
Impeller C-line(X)(IN.)	11
Eye Area (IN^ 2)	58.2

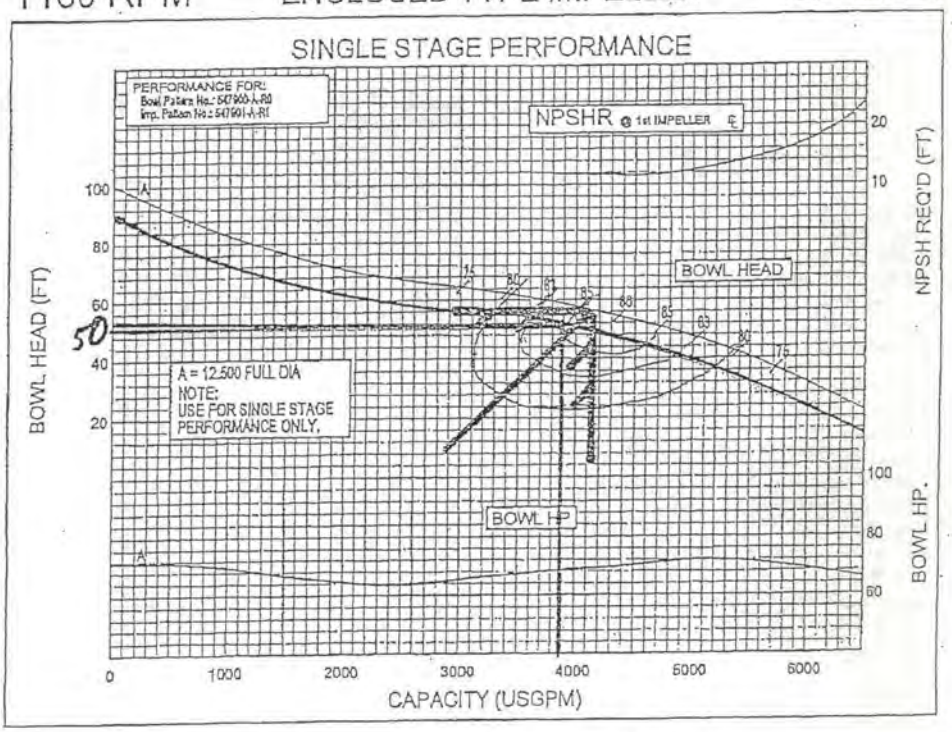
NOTES

Performance indicated based on cold water with specific gravity of 1.0.

* Standard Construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.



3900 $\frac{3900 \times 50}{3960 \times 0.85} = 58$ BHP

OK

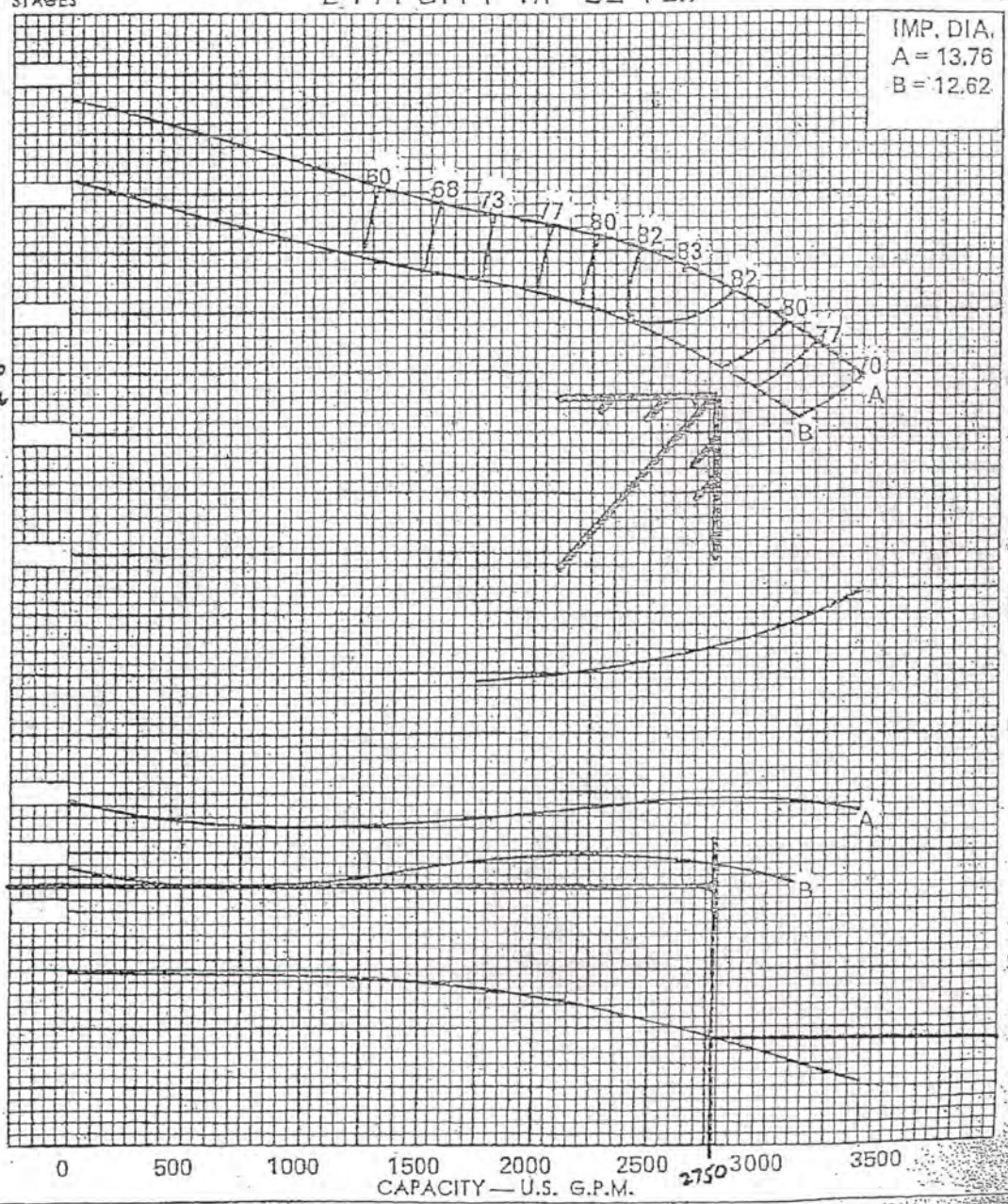
CURVE NO.
12-146
11-1-77

No. Stages	Eff. Change	MATERIAL	Eff. Change
1	−1	IMP.—C.I.	−1
2	0	IMP.—NI-RI	−1
3	.	BOWL—BRZ.	. 0
4		BOWL—NI-R.	0

18 RKMC 1180 R.P.M.

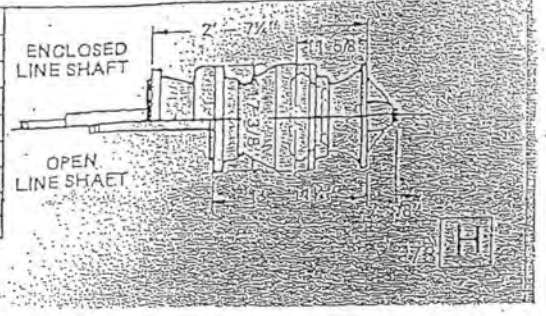
SINGLE STAGE LAB PERFORMANCE WITH STANDARD MATERIALS. EFFICIENCY SHOWN FOR 2 OR MORE STAGES. HORSE POWER SHOWN FOR ONE STAGE BASED ON 2 STAGE EFFICIENCY. CORRECTIONS SHOULD BE MADE FOR STAGES AND MATERIAL.

(2) CITY OF BENTON HARBOR LOW SERVICE #4 PROPOSED NEW DESIGN
2777 GPM AT 52' TDH

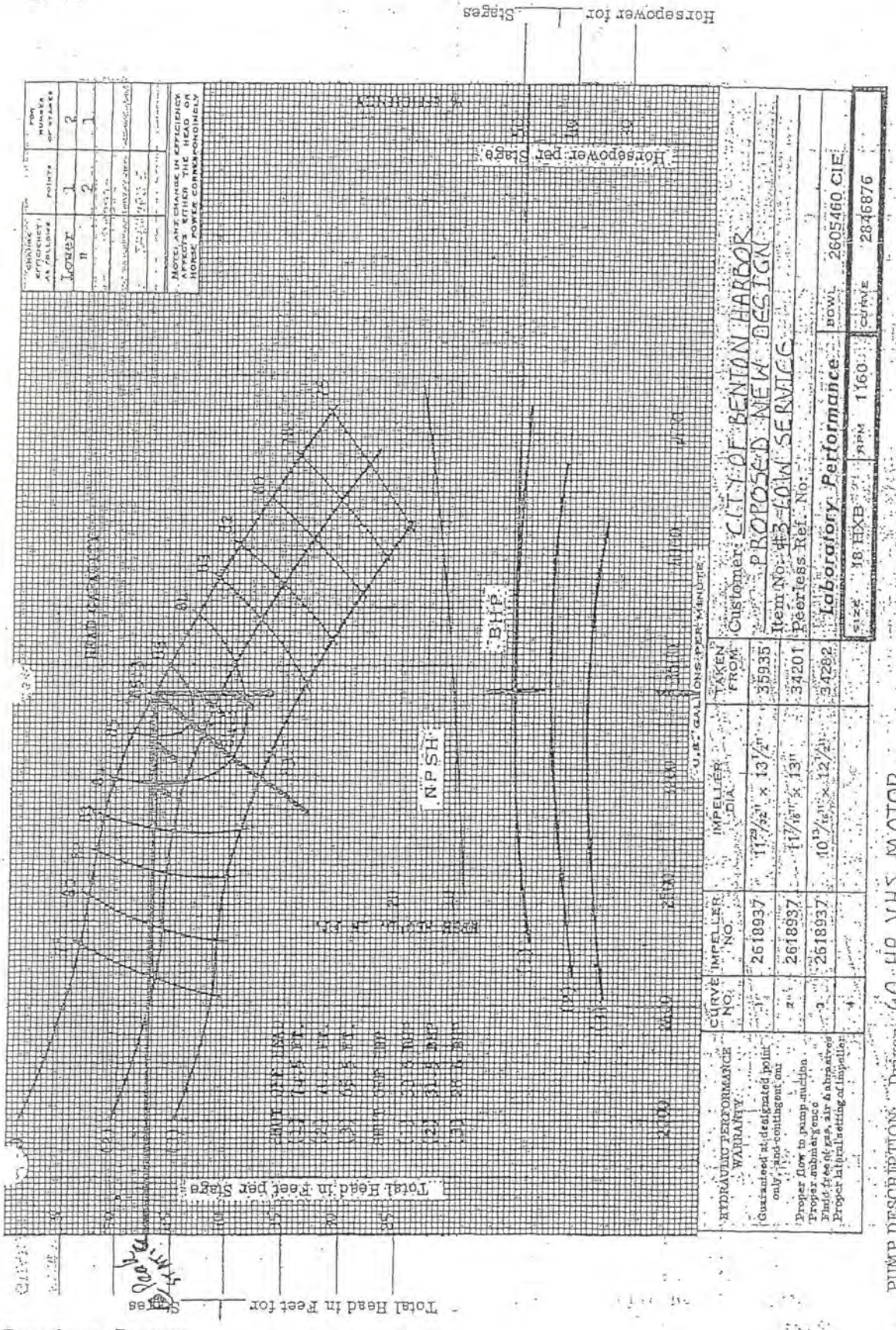


NOTE: IMPELLER TRIM WILL BE APPX. 10.30". THIS NEEDS TO BE CONFIRMED BY THE FACTORY

EYE AREA — SQ. IN.	=	56.4		IMPELLER WT.-LBS.	= 58
WR² PER IMPELLER	=	7.2	LB.-FT.²	ONE STAGE WT.-LBS.	= 1050
MAX. SPHERE SIZE	=	1.42	In.	ADD'L STAGE WT.-LBS.	= 340
MAX. NO. STD. STAGES	=	10		IMPELLER NUMBER	= 8RK35
MAX. OPERATING P.S.I.	=	390		DISCH. SIZES	= 12,14
STD. LATERAL	=	0.69	In.	SUCTION SIZES	= 14
STD. SHAFT DIA.	=	2.187	In.	MAX. LATERAL	= 1.00 In.
MAX. SHAFT DIA.	=	2.437	In.	BOWL CONN.	FLANGED
MIN. SUBMERGENCE	=	28	In.	ADD 14%	" PER ADDITIONAL STAGE.



VERTICAL TURBINE PUMPS



HYDRAULIC PERFORMANCE WARRANTY	CURVE NO.	IMPELLER NO.	IMPELLER DIA.	TAKEN FROM
Guaranteed at designated point only, and contingent on:	1	2618937	11 29/32" x 13/4"	35935
Proper flow to pump suction Proper submergence Fluid free of gas, air & abrasives Proper lateral setting of impeller	2	2618937	11 7/16" x 13"	34201
	3	2618937	10 13/16" x 12 1/2"	34282
	4			

Customer: CITY OF BENTON HARBOR
PROPOSED NEW SERVICE DESIGN
Item No: #3-40W
Peerless Ref. No:
Laboratory Performance
SIZE 18 HXB RPM 1160 CURVE 2846876 BOWL 2605460 CIE

PUMP DESCRIPTION: "Driver 60 HP VHS MOTOR ; Head ; Column
GUARANTEED FIELD PERFORMANCE: Capacity 3500 gpm; Head 47 ft; Eff 83.3 % BHP 49.9

CITY OF BENTON HARBOR #2 LOW SERVICE

VI-109

9/1/01

PROPOSED NEW DESIGN

2250 GPM AT 52' TDH 2 STAGES

1180 RPM ENCLOSED TYPE IMPELLER 16MKM

NUMBER OF STAGES	EFFICIENCY CHANGE (NO. OF POINTS)
1	- 2
2	- 1
3	- 0

HORSEPOWER WILL BE AFFECTED BY CHANGE IN EFFICIENCY

PUMP DATA

Shaft Dia.(IN)	2 1/4
Maximum Sphere (IN)	1 3/8
Maximum Head (FT)*	718
Min. Submergence (IN)**	32
Impeller Weight (LBS)	32.3
Thrust Constant (K)	20
Thrust Bal Const. (K)	0
Bowl O.D.(IN.)	15 3/8
Bowl Height (IN.)	13
Bell DIA. (T) (IN.)	15 3/4
Strainer height (IN.)	10 1/8
Impeller C-line(X)(IN.)	11
Eye Area (IN^ 2)	51.3

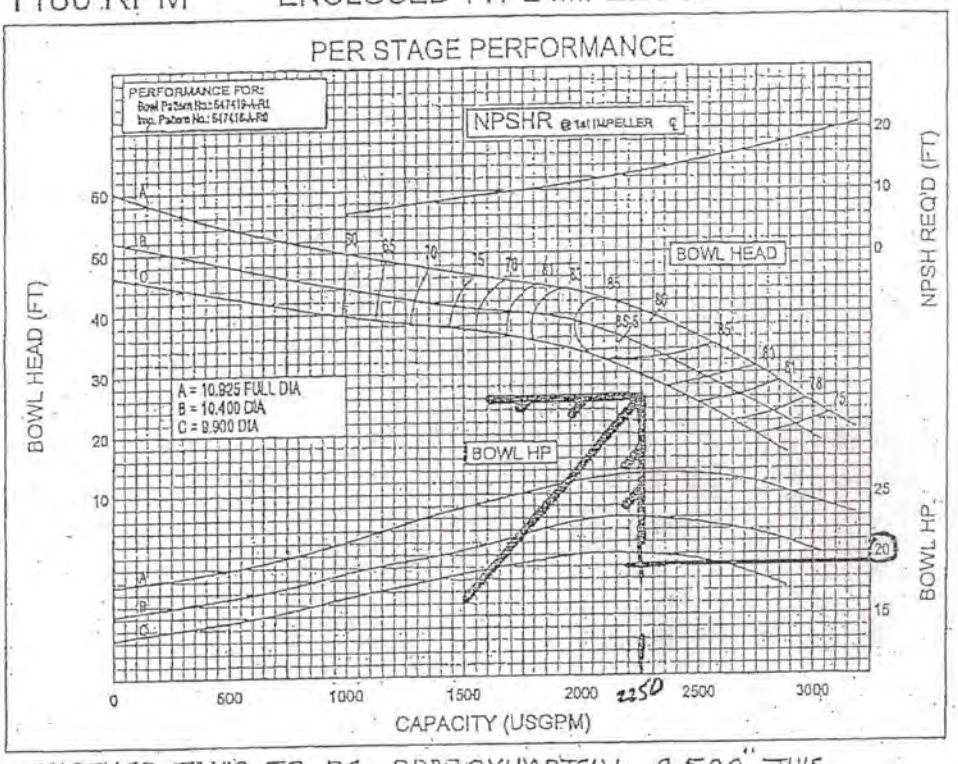
NOTES

Performance indicated based on cold water with specific gravity of 1.0.

* Standard Construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.



NOTE: IMPELLER TRIM TO BE APPROXIMATELY 9.500". THIS WILL BE CONFIRMED BY THE FACTORY

~~1170 RPM ENCLOSED TYPE IMPELLER 16MKM~~

NUMBER OF STAGES	EFFICIENCY CHANGE (NO. OF POINTS)
1	
2	
3	

HORSEPOWER WILL BE AFFECTED BY CHANGE IN EFFICIENCY

PUMP DATA

Shaft Dia.(IN)	
Maximum Sphere (IN)	
Maximum Head (FT)*	
Min. Submergence (IN)**	
Impeller Weight (LBS)	
Thrust Constant (K)	
Thrust Bal Const. (K)	
Bowl O.D.(IN.)	
Bowl Height (IN.)	
Bell DIA. (T) (IN.)	
Strainer height (IN.)	
Impeller C-line(X)(IN.)	
Eye Area (IN^ 2)	

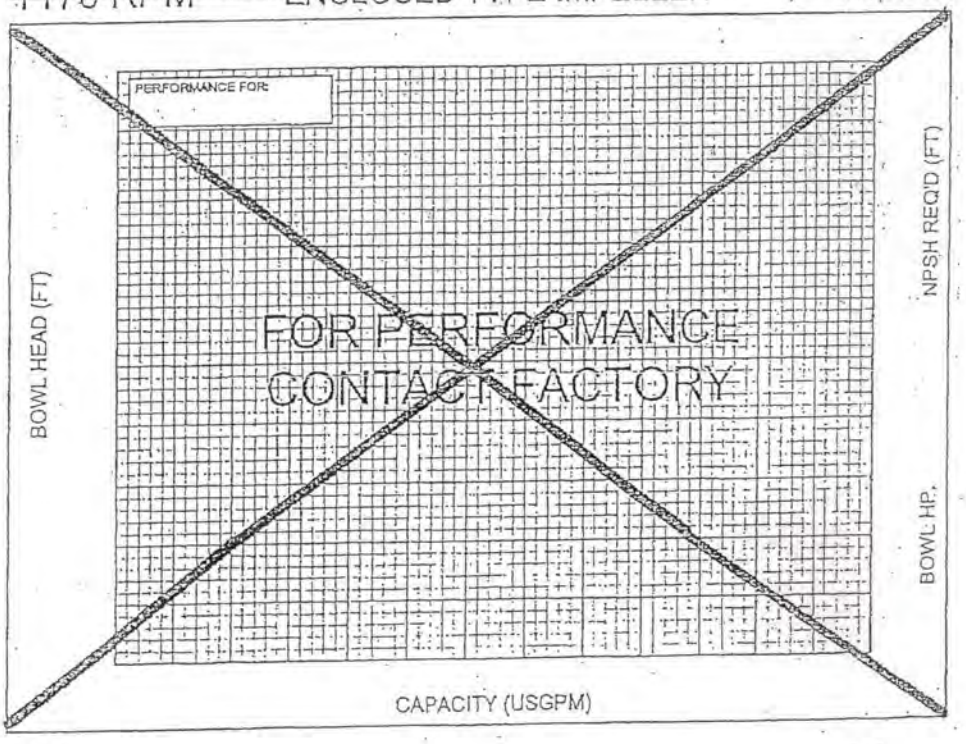
NOTES

Performance indicated based on cold water with specific gravity of 1.0.

* Standard Construction.

** Minimum submergence over lip of bell to prevent vortexing.

Efficiency improvements are available in certain instances. Please contact the factory.



JUNE 1, 1976
Supersedes 4/22/76

CURVE NO. 18-126

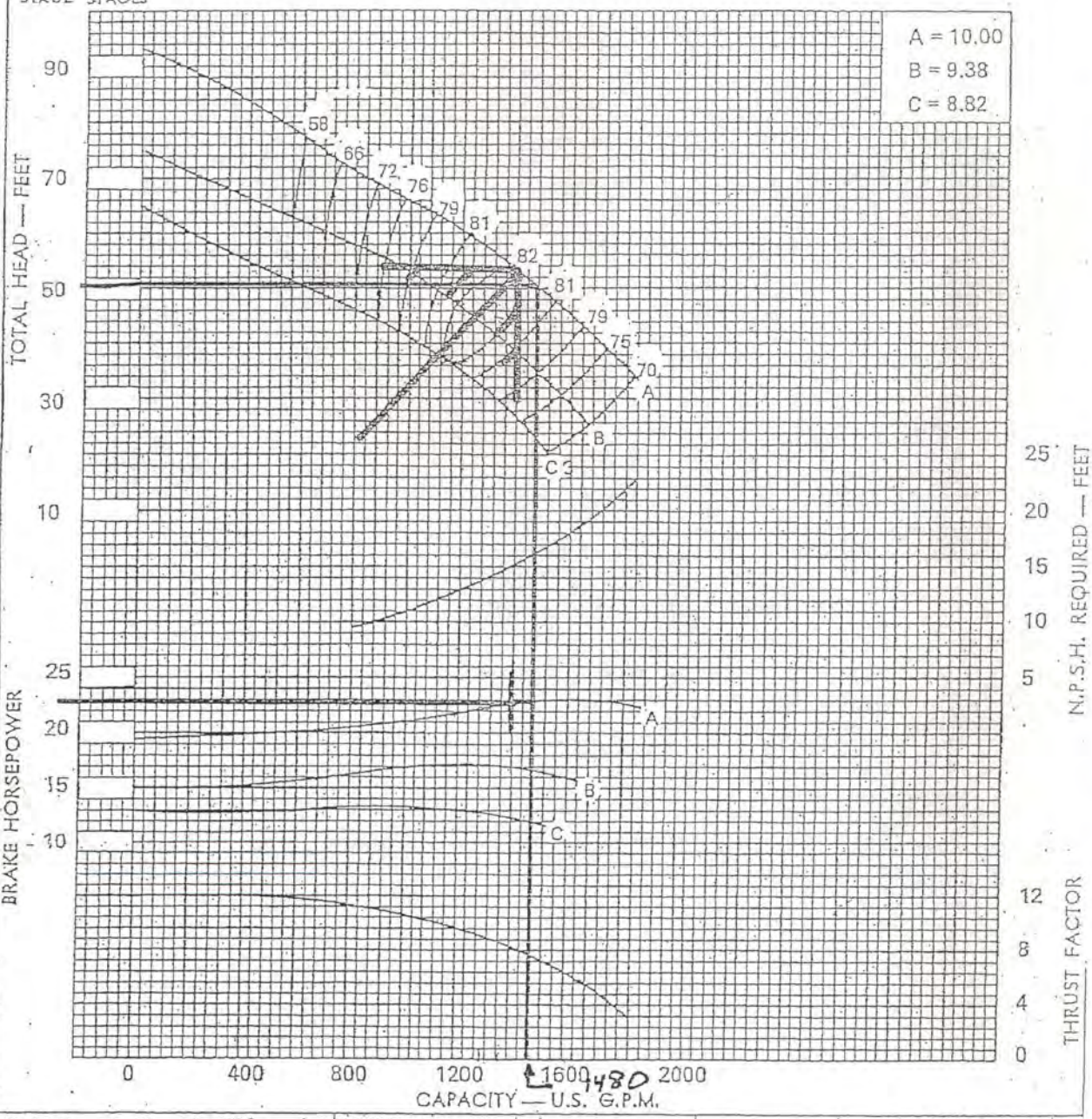
LAYNE & BOWLER, INC.
MEMPHIS, TENNESSEE

No. Stages	Eff. Change	MATERIAL	Eff. Change
1	-2	IMP.—C.I.	-2
2	-1	IMP.—NI-RI	-1
3	0	BOWL—BRZ.	-1
4		BOWL—NI-R.	-1

12TLC 1760 R.P.M.

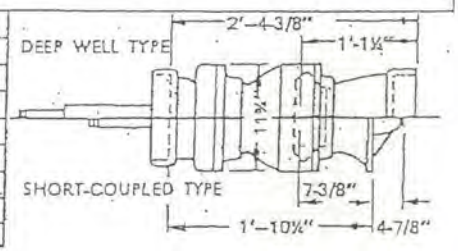
SINGLE STAGE LAB PERFORMANCE WITH STANDARD MATERIALS. EFFICIENCY SHOWN FOR 4 OR MORE STAGES. HORSE POWER SHOWN FOR ONE STAGE BASED ON 4 STAGE EFFICIENCY. CORRECTIONS SHOULD BE MADE FOR STAGES AND MATERIAL.

ONE ( ) STAGE STAGES



CITY OF BENTON HARBOR
#1 LOW SERVICE
PROPOSED NEW DESIGN: 1400GPM AT 54'TDH
Peak 51@ TDH

EYE AREA — SQ. IN.	=	28.3		IMPELLER WT.-LBS.	= 22.4
WR² PER IMPELLER	=	1.52	LB.-FT.²	ONE STAGE WT.-LBS.	= 328
MAX. SPHERE SIZE	=	1.12	in.	ADD'L STAGE WT.-LBS.	= 123
MAX. NO. STD. STAGES	=	10		IMPELLER NUMBER	= 6T13A
MAX. OPERATING P.S.I.	=	410		DISCH. SIZES	= 8,10
STD. LATERAL	=	0.50	in.	SUCTION SIZES	= 10
STD. SHAFT DIA.	=	1.687	in.	MAX. LATERAL	= 1.00 in.
MAX. SHAFT DIA.	=	1.937	in.	BOWL CONN.	THREADED-COLLET
MIN. SUBMERGENCE	=	33	in.	ADD 10	" PER ADDITIONAL STAGE.



CITY OF BENTON HARBOR
WATER FILTRATION PLANT
BASIS OF PROCESS DESIGN SUMMARY

Updated – August 26, 2009 (Revised Low Service Pumps 10-01-09)
Prepared By – Rick Smigielski, Abonmarche Consultants, Inc

I. **LAKE MICHIGAN INTAKE** (Existing to Remain)

Number of Intakes – 1 main
2 emergency

Crib – Riser: 10' diameter lower part
12' diameter at the top

Rim: 13.5' above lake bottom
Openings: Forty (40) 2" x 12" cedar slats around opening
Distance from shore: 3,375'
Intake Pipe: 36" steel
Emergency Intakes: One (1) at 1,500' from shore
One (1) at 2,500' from shore

Intake Pipe Capacity: 24 MGD at an entrance velocity of 5.25 fps.

12 MGD at an entrance velocity of 2.7 fps

Zebra Mussel Control: Chlorine solution at crib
Back Flush Capabilities: Yes (12" system high pressure)
Lake Levels based on NAVD 88: Low @ 576.00
High @ 582.50

II. **PLANT INLET WORKS** (Existing to Remain)

Inlet Pipe: 30"
Capacity: 24 MGD
Shut Off Valve: 24" Cone Valve
Inlet Screen: 60" wide
Wet area at low water level = 85 SF
Wet Area at high water level = 120 SF
Screen Flow Velocities at 12 MGD @ low water level = 0.22 CFS
@ high water level = 0.15 CFS

Bypass – None

III. LOW LIFT PUMPS

Type - Turbines
Wet Well (Existing to Remain)
Area – 26.5' x 18.0' = 477 SF
Volume @ low water level = 60,655 gallons
@ high water level = 85,631 gallons

Pumps –
Low Service Pump #1 – 1,408 gpm @ 51' TDH (25HP)
Low Service Pump #2 – 2,250 gpm @ 52' TDH (40HP)
Low Service Pump #3 – 3,400 gpm @ 48' TDH (60 HP)
Low Service Pump #4 – 2,750 gpm @ 52' TDH (50 HP)
Low Service Pump #5 – 3,900 gpm @ 48' TDH (60 HP)
Drain Sump Pump 1,000 gpm @ 30' TDH(10 HP)

IV. FLASH MIXER

Location – New Plate Settler Building
Quantity - 2
Tank Size – 11' x 11' x 10.5' SWD each
Capacity – 8600 gallons each
Chamber Detention Time – 2 minutes at ADF
Type – Propeller
Speed - Variable
Motor – 20 Hp

V. FLOCCUATION BASIN

Location – New Plat Settler Building
Number of Trains – 2
Basin Size – 50' long x 30' wide x 15' SWD
Basin Capacity - 168,300 gallons
Basin Detention Time at ADF = 40 minutes total
Number of mechanical stages – 3 @ 15' long each
Volume of each mechanical stage - 50,497 gallons
Detention time per mechanical stage - 12 minutes
Number of hydraulic stages – 1 @ 5' long each
Volume of each hydraulic stage – 16,832 gallons
Detention time per hydraulic stage - 4 minutes
Number of flocculators – 3 per basin
Speed Control – motor VFD's
Paddle configuration – series
Flocculator Motors – Stage 1 – 3 Horsepower
Stage 2 – 2 Horsepower
Stage 3 – 1 Horsepower

VI. PLATE SETTLERS

Location – New Plate Settler Building
Number of Trains – Two (2)
Basin Size – 40' long x 30' wide x 15' SWD
Average raw water influent turbidity – 4 NTU
Peak raw water influent turbidity – 70 NTU
Effluent raw water turbidity at average influent turbidity – 1 NTU
Effluent raw water turbidity at peak influent turbidity – 3 NTU
Design Loading Rate – 0.3 gpm/SF
Effective Settling Area – 12,890 SF
Projected Settling Area – 15,433 SF
Actual settling area – 26,907 SF
Number of effluent troughs per basin - 2

Plates:
- Width – 4.5'
- Length – 10.0'
- Number of rows per basin – 4
- Plate Settler Area – 45.0 SF
- Total Plates per Basin – 598
- Flow per Plate – 6.97 gpm
- Actual Settling Area – 26,907 SF
- Angle of Plate Inclination - 55°

Cartridges – Number of cartridges per row – 2
- Number of Plate Settlers per cartridges – 75

Discharge Tubes
- Number of orifices per plate – 4
- Diameter of orifices – 0.75 inched
- Head loss through orifices – 0.78 inches

Effluent Troughs
- Number of troughs – 2
- Width of Trough - 20 inches
- Flow per Trough at design – 2,084 gpm
- Flow per Trough at peak – 2,431 gpm
- Head loss over weir – 1.01 inches

VII. PLATE SETTLER SLUDGE COLLECTION

Location – New Plate Settler Building
Type – Suction header
Suction header pipe size – three inch
Collector pipe size – four inch
Withdraw rate – 200 gpm
Withdraw time – 15 minutes
Discharge volume – 3,000 gallons

VIII. **FILTERS**

Location Existing Process Building
Quantity – 12 beds
Type – Two (2) media sand and anthracite
Operation – Constant head (rate of flow controllers)
Bed Area – 349 SF
Filtration Rate – 4 gpm per SF maximum
Filter Cell Capacity – 1.00 MGD @ 2.0 gpm/sf – Design
1.25 MGD @ 2.5 gpm/sf – Peak
2.00 MGD @ 4.0 gpm/sf – Max at clean filter
Filter Backwash
Backwash rate per filter cell – 5,200 to 5,500 gpm
Backwash rate per filter SF – 15.7 gpm
Backwash period – 5-10 minutes
Backwash waste volume – 45,000 gallons
Surface Wash – System pressure (70 psi @ 600 gpm)
Surface Wash Waste Volume – 2,000 gallons/backwash

New Filter to Waste Process
Filter flow rate – 2 gallons per SF per minute
Filter to waste rate – 700 gpm
Filter to waste discharge time – 5-10 minutes
Filter to waste volume – 3,500 – 7,000 gallons

Total wastewater per backwash cycle – 52,000 gallons

IX. **FINISHED TREATED WATER STORAGE**

Type – Underground
Number of tanks – 2
Volumes – 1,000,000 gallons each / 2,000,000 gallons total
Tank Size – 100' x 100' x 13' SWD each
Overflow protected
Inlets/Outlets – Four at 16" diameter per tank
New flow baffles to be installed

X. **HIGH LIFT PUMP SUCTION WELL**

Type – Underground
Number of Tanks – 1
Volume – 97,000 gallons
Tank Size – 49' x 16' x 16.5 SWD
Tank inlet pipe – 1@ 36" from reservoirs
Tank Outlet – 2 @ 30" (to high service pumps and backwash pumps)

XI. HIGH SERVICE (Lift) PUMPS

Location – Main Building
Type – Turbines
Quantity – 5
High Service Pump #1 – 1,410 gpm @ 200' TDH – 100 HP
High Service Pump #2 – 2,980 gpm @ 200' TDH – 200 HP
High Service Pump #3 = 3,000 gpm @ 202' TDH – 200 HP
High Service Pump #4 – 3,000 gpm @ 202' TDH – 200 HP
High Service Pump #5 – 1,410 gpm @ 200' TDH – 100 HP

XII. DISTRIBUTION SERVICE

Plant Discharges – 2 @ 20"
Venturie Flow Meters on each 20" discharge
Design plant discharge – 12 MGD
Discharge Velocities with both discharges on line at 12 MGD = 4.2 feet per second
Discharge Velocities with one discharges on line at 12 MGD = 10.5 feet per second
Discharge Velocities with both discharges on line at 18 MGD = 6.4 feet per second

XIII. PLANT DRAIN AND BACKWASH SOLIDS DISPOSAL

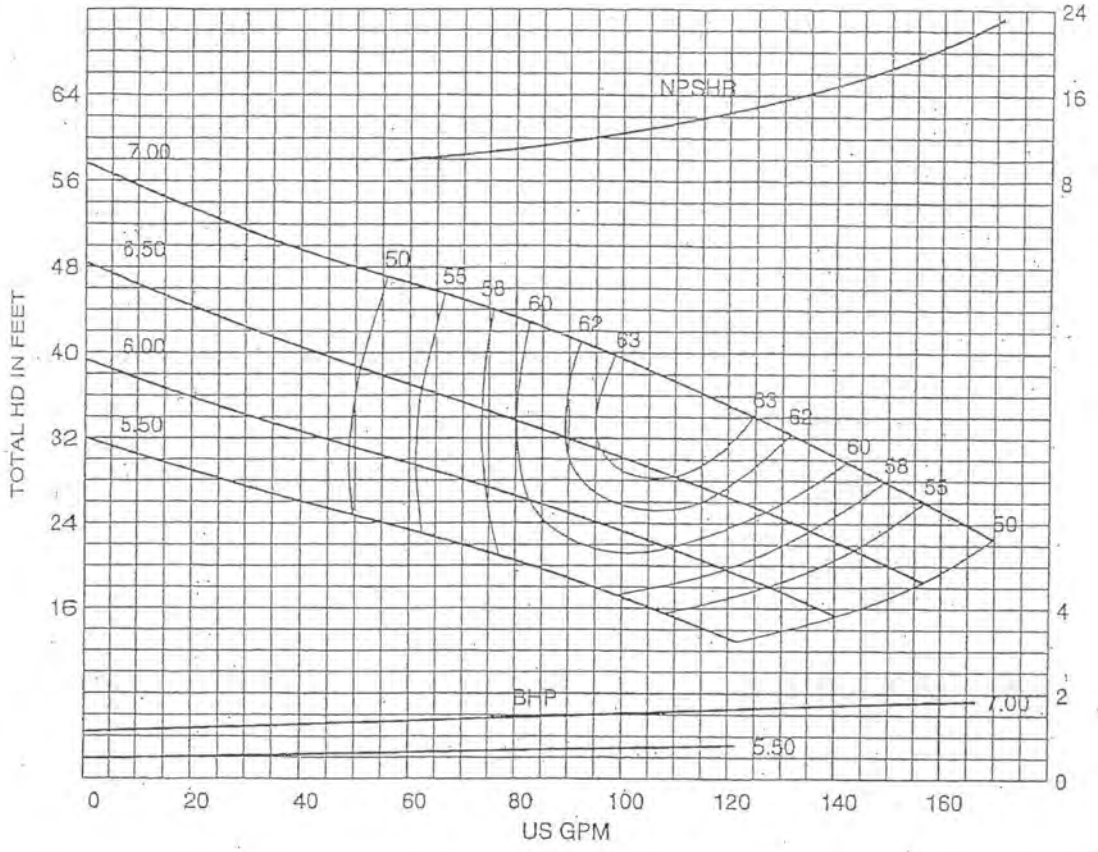
Type – Lagoon system
Number of cells – 2 (one primary and one secondary)
Total liquid solids discharged per day (initial) – 235,000 gallons
Total alum waste solids discharged per day (initial) – 310 ppd

Soils
Type – dune sand
Soils perculation rate – 6 to 20 inches per hour
Peak max design perculation rate – 2 inches per hour

Lagoon
Bottom surface area – 36,800 SF
Perculation rate – 235,000 gpd / 37,000 SF = 6.4 gallons per SF per day
10 inches per day or 0.42 inches per hour

Bottom elevation – 583.00
100 year Flood elevation – 585.00
Normal lagoon HWL after filter backwash – 583.85
Lagoon HWL after filter backwash with 100 year floor – 585.85
Overflow weir elevation – 586.25
Lagoon high water elevation at overflowing conditions – 586.28

Frequency of lagoon cleaning – once per year (summer)



2"

5411K VERTICAL FOR FLEXIBLE SHAFTING

5421K HORIZONTAL

5431K VERTICAL BILTOGETHER

5431KW SUBMERSIBLE

5441K VERTICAL CLOSE COUPLED

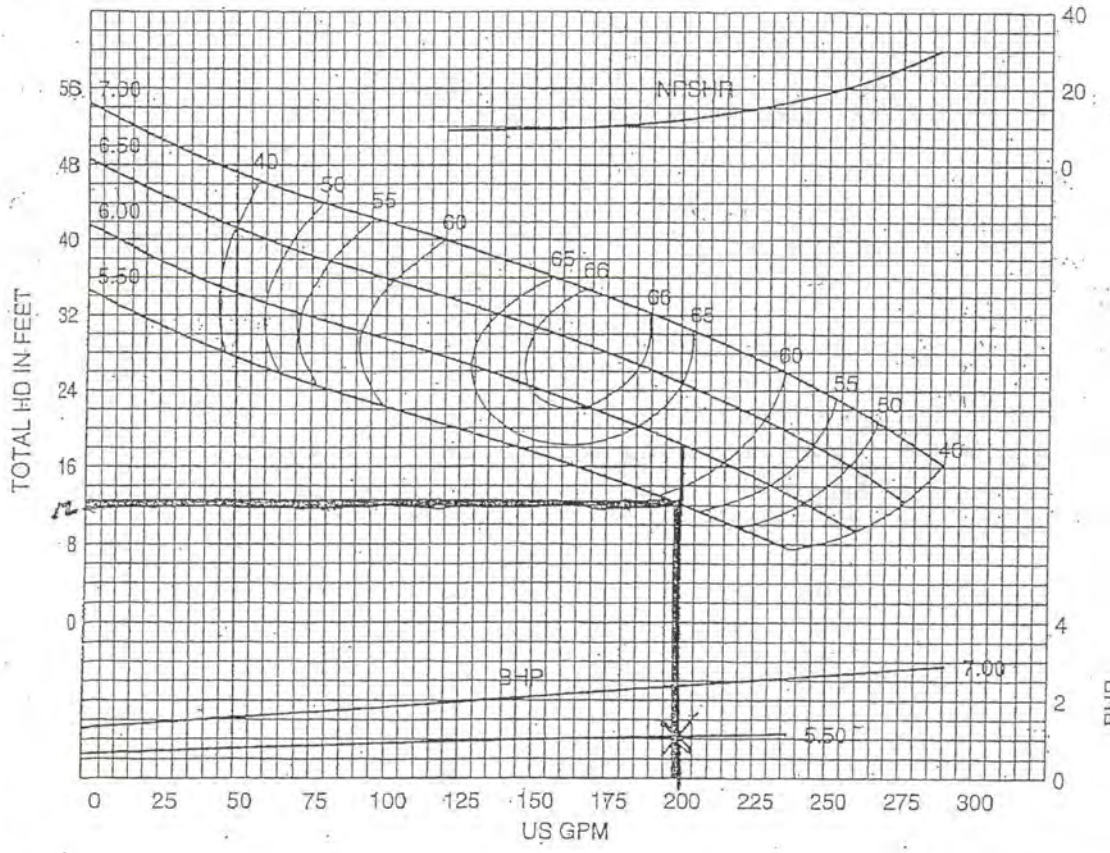
1750 RPM TYPE K-BLADE-LESS

SUCTION SIZE
5421:2"
OTHER:2"

IMPELLER T2A1X

INLET AREA
6.51 SQ.IN.

MAX.SPHERE
1 1/2"



3"

5411K VERTICAL FOR FLEXIBLE SHAFTING

5421K HORIZONTAL

5431K VERTICAL BILTOGETHER

5431KM&W SUBMERSIBLE

5441K VERTICAL CLOSE COUPLED

1750 RPM TYPE K-BLADE-LESS

SUCTION SIZE
5421:3"
OTHER:3" OR 4"

IMPELLER T3A1X

INLET AREA
11.41 SQ.IN.

MAX.SPHERE 2"

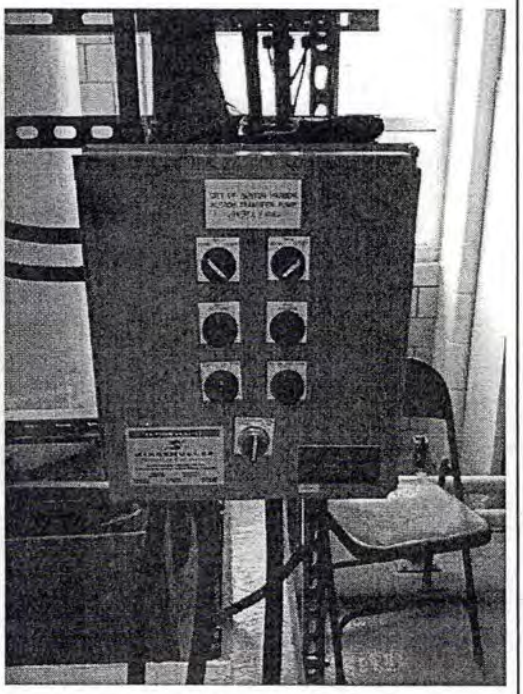
Above Sludge Pump
For Plate Settlers

Appendix F

Survey Photos

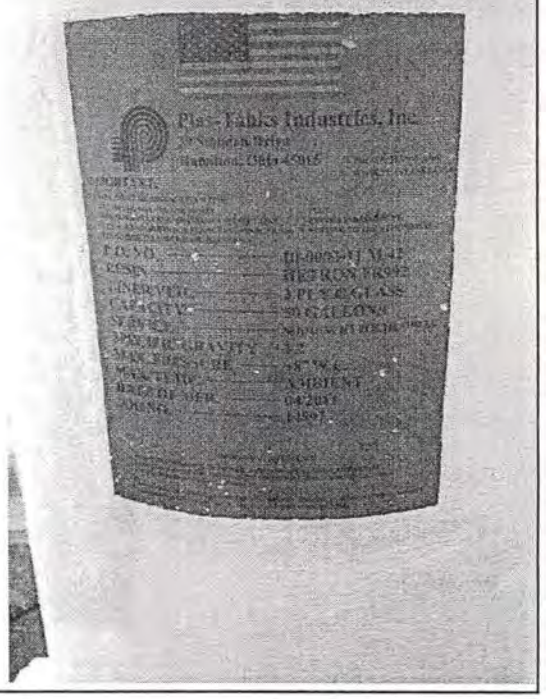
Sodium Hypochlorite
Day Tank Transfer
Pump Control Panel

February 26, 2015

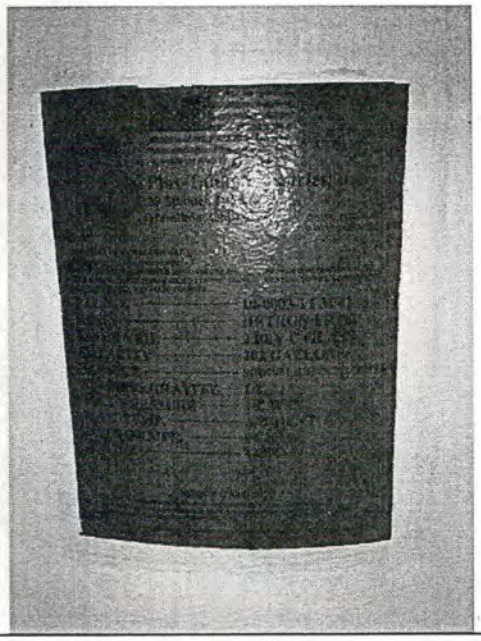


50-Gallon
Sodium Hypochlorite
Day Tank

February 26, 2015

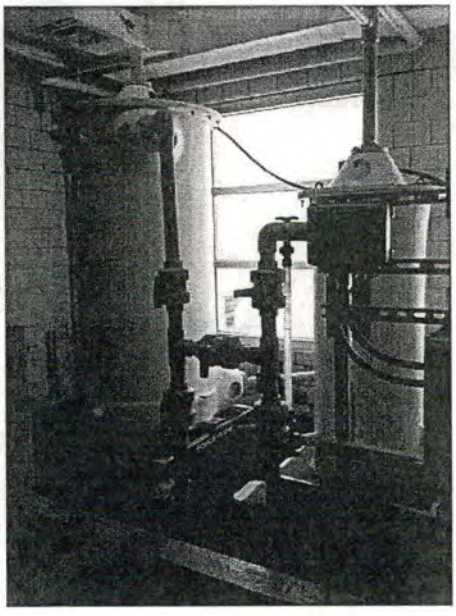


200-Gallon Sodium Hypochlorite Day Tank



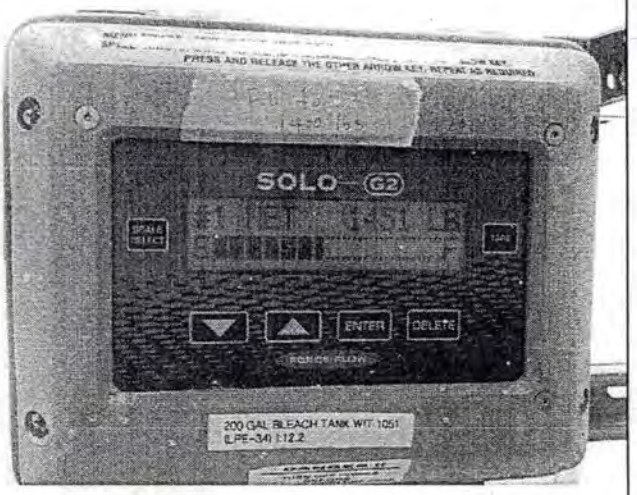
February 26, 2015

Sodium Hypochlorite Day Tanks



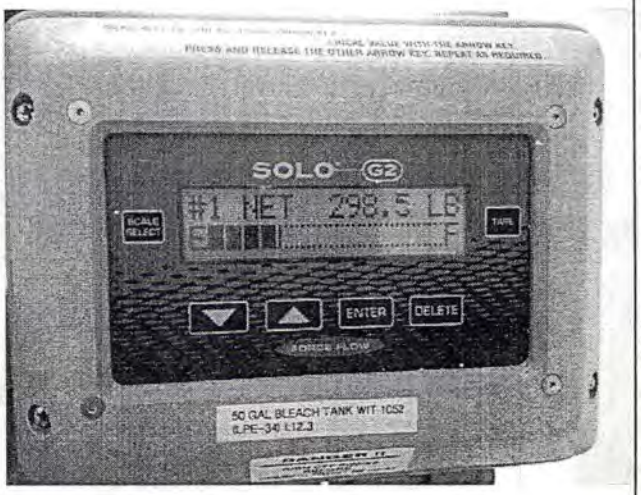
February 26, 2015

Sodium Hypochlorite Day Tank Scale Reading



February 26, 2015

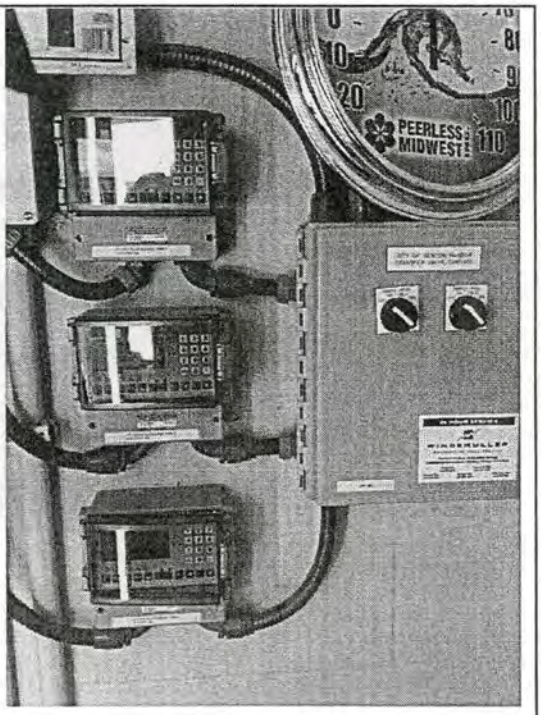
Sodium Hypochlorite Day Tank Scale Reading



February 26, 2015

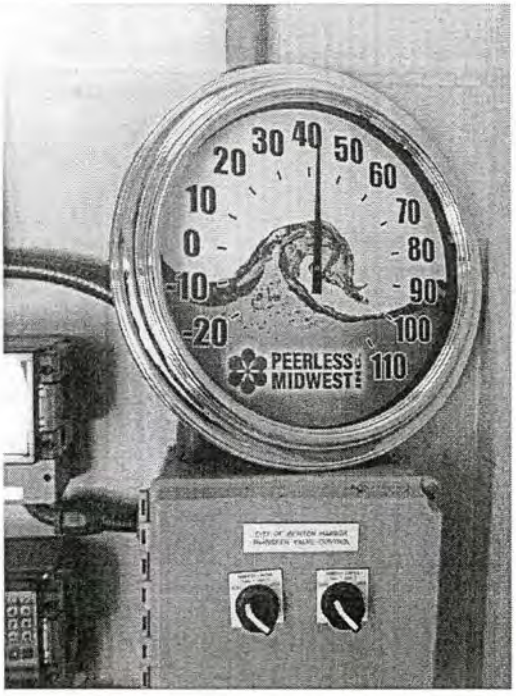
Bulk Sodium
Hypochlorite Transfer
Control Panel

February 26, 2015



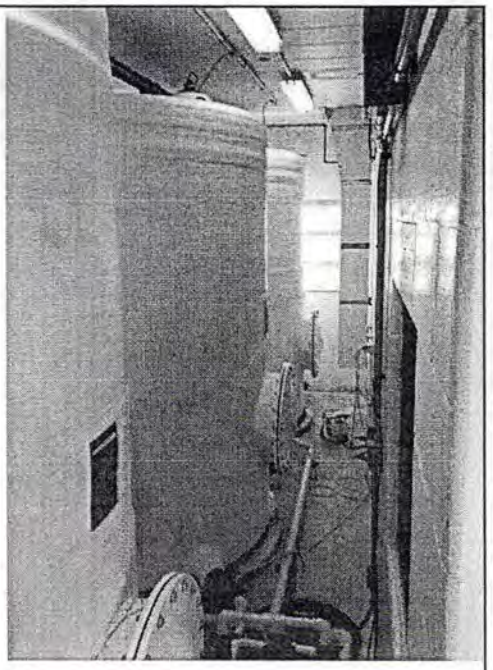
Bulk Sodium
Hypochlorite Room
Temperature Gauge

February 26, 2015



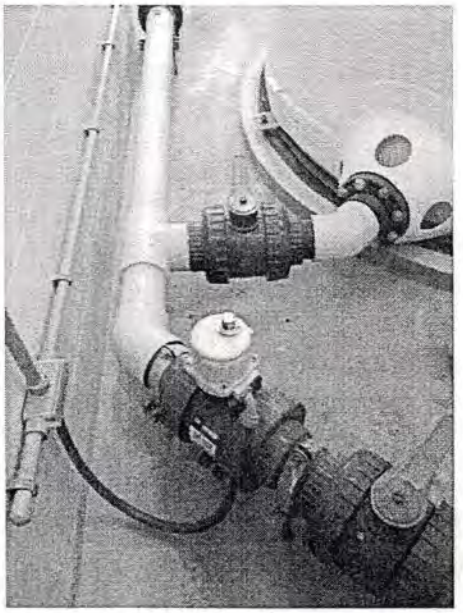
Bulk Sodium
Hypochlorite Tanks

February 26, 2015

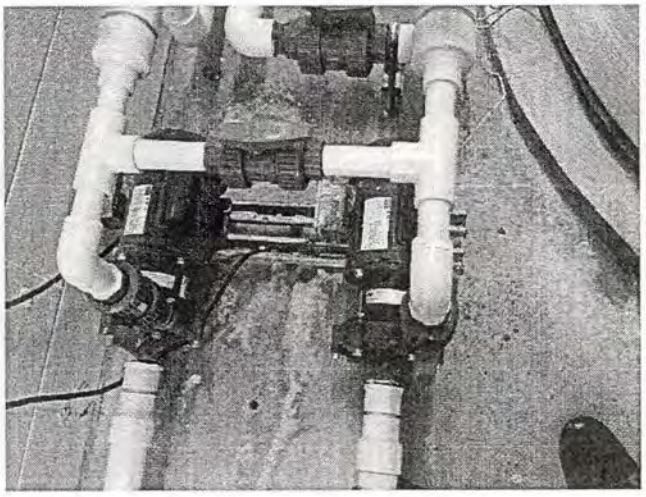


Bulk Sodium
Hypochlorite
Transfer Valve

February 26, 2015

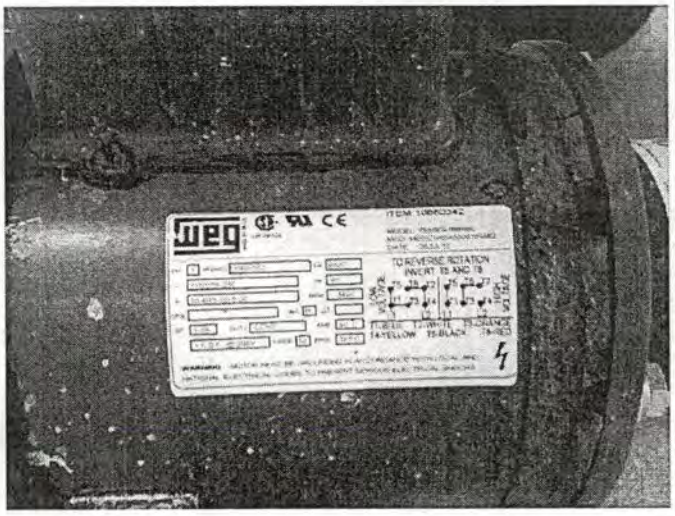


Bulk Sodium Hypochlorite Transfer Pumps



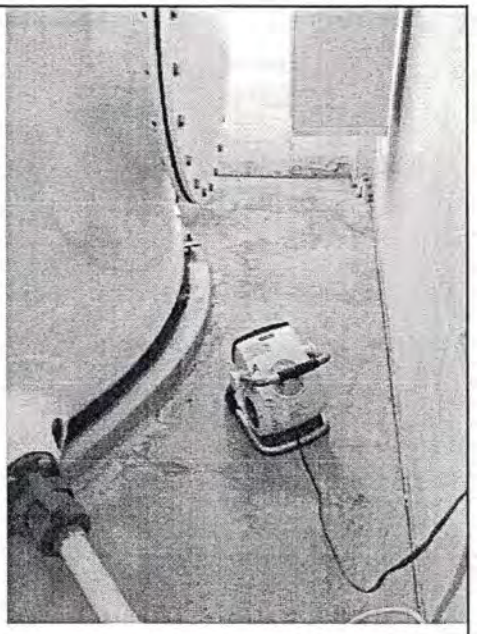
February 26, 2015

Bulk Sodium Hypochlorite Transfer Pump Plate



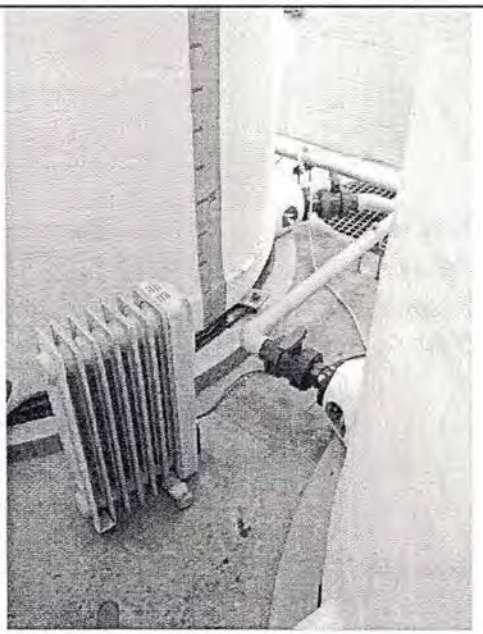
February 26, 2015

Bulk Sodium Hypochlorite Space Heater



February 26, 2015

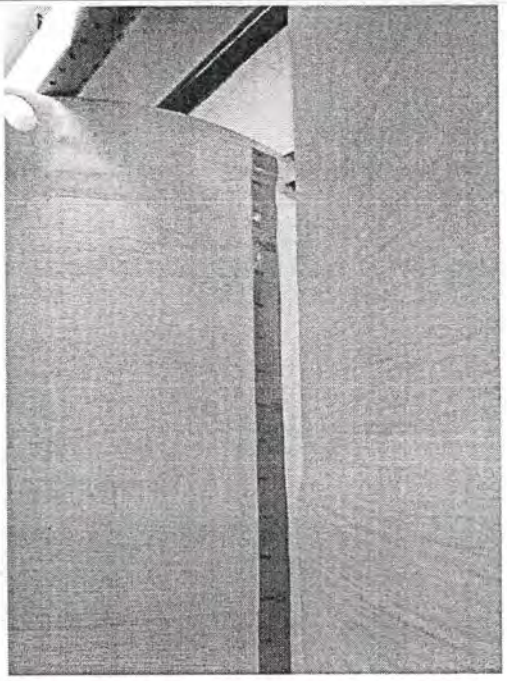
Bulk Sodium Hypochlorite Space Heater



February 26, 2015

Bulk Sodium Hypochlorite Fill Gauge

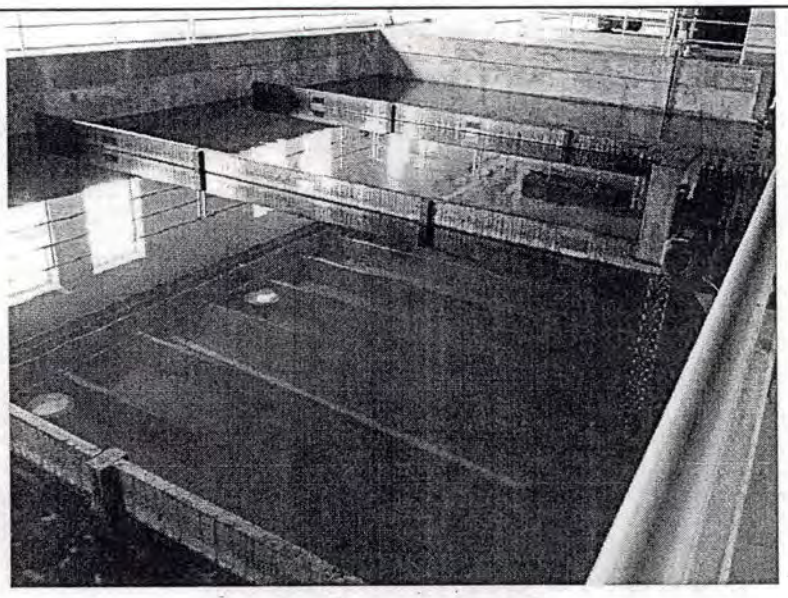
February 26, 2015



Bulk Sodium Hypochlorite Storage Room Door

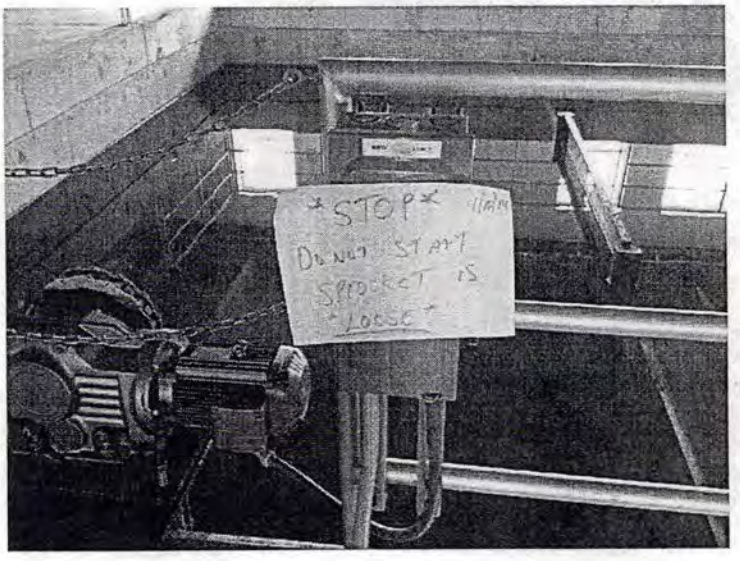
February 26, 2015





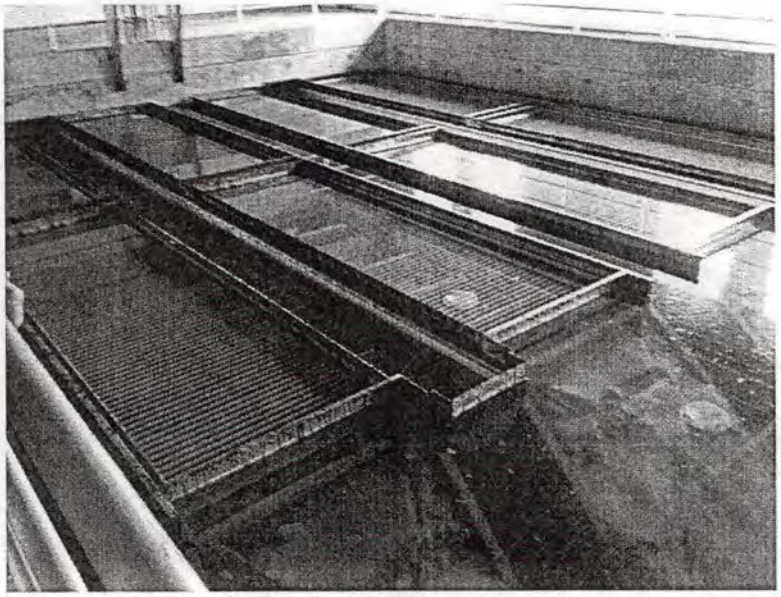
April 16, 2015

Flocculation Tanks



April 16, 2015

Flocculation Tank
Motor Drive



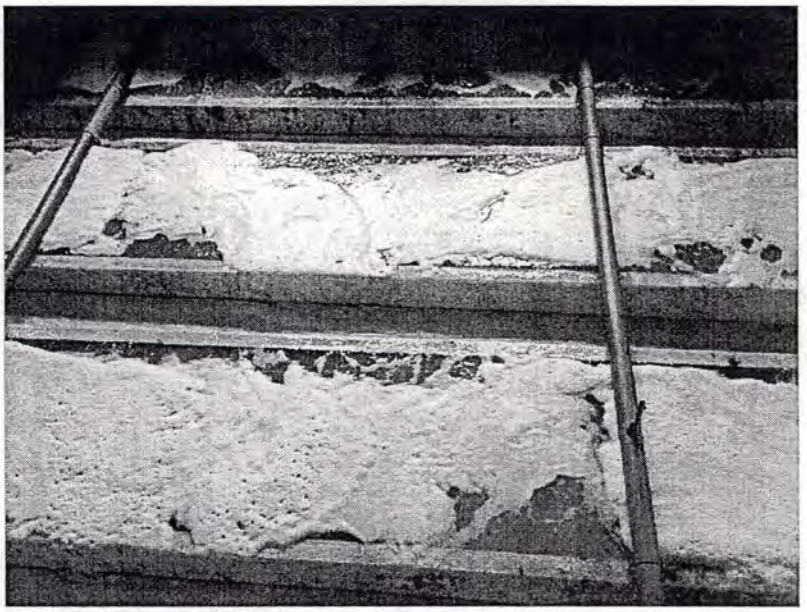
April 16, 2015

Plate settlers



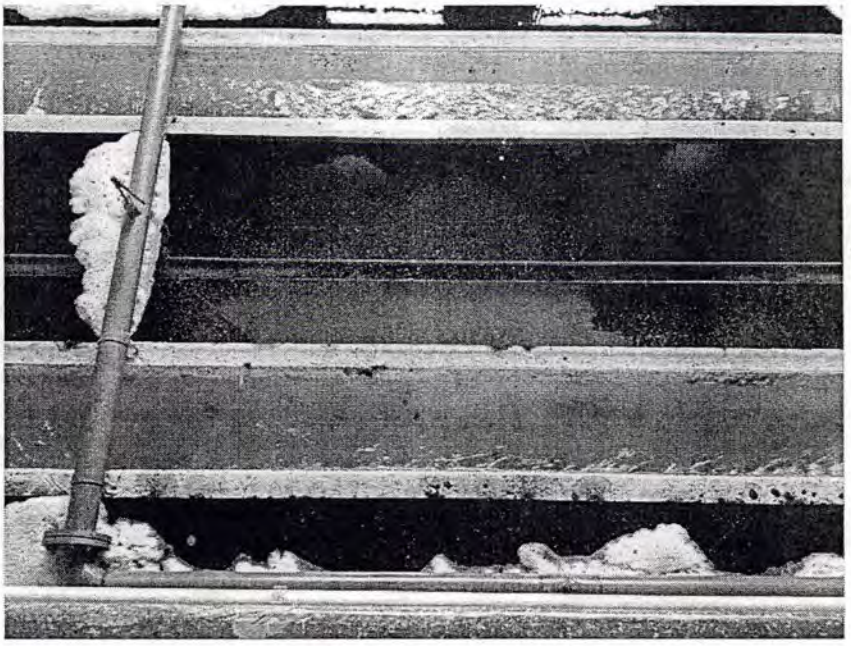
April 16, 2015

Flocculation Tank
Motor Drive



April 16, 2015

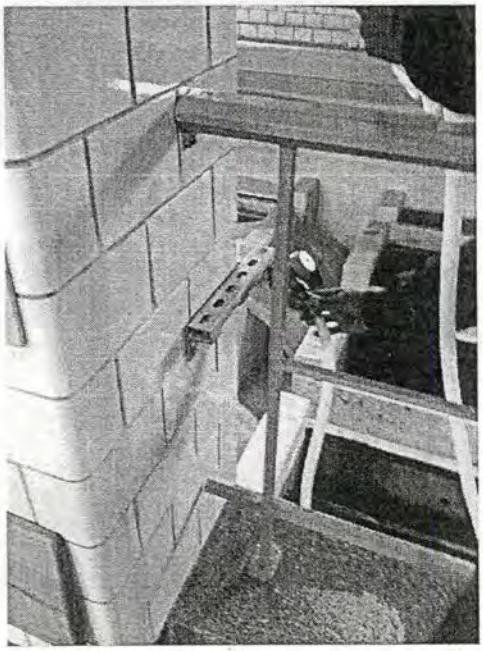
Filter 3-4 Backwashing



April 16, 2015

Filter 3-4 Backwashing

Filter Wash Hose Connection



April 16, 2015



April 16, 2015

Filter Wall Washing

Lab Still



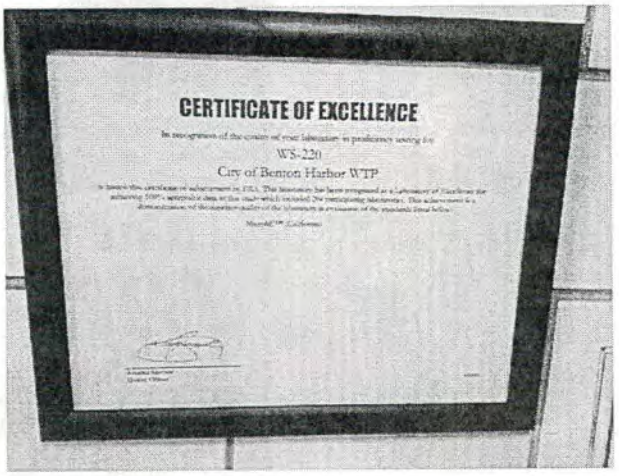
April 16, 2015

Lab Certification by DEQ



April 16, 2015

Lab Certificate of Excellence



April 16, 2015

From:	Sarkipato, Ernest (EGLE)
To:	Mike O"Malley; dwatson@cityofbentonharbormi.gov
Cc:	Bolf, Michael (EGLE)
Subject:	RE: Reply demanded to be made Close of business today to Michael Bolf letter dated 04 01 2019 and addressed to Mayor Marcus Muhammad
Date:	Thursday, May 16, 2019 8:36:59 AM
Attachments:	R325.11008.docx Copy of SW MOR Template.xlsx

Mike –

Thank you for the thorough response**.** *Your extension for the meter installation is granted*. Attached is an updated workflow with new due dates. Please note: **DARWIN we need to talk about rate adjustments based on the rate study, as well as your plan for revamping the rate collection process.**

Mike's detailed reply brings in a couple follow-up questions/comments:

-Individual Filter turbidities should also be available on the historian (maybe when the meter gets integrated)

-Who is Darold Harlan …. Is this person from F&V?

-When will F&V be onsite, and what is the contractual arrangement for being onsite (i.e. frequency, on-call, etc)?

-You asked for a legal reference for metering finished water. Finished water is required to be measured (not calculated) by R325.11008 (9), see attached excerpt. Hopefully this satisfies your request for a reference.

-With respect to the DEQ's format on the MOR, I tend to agree with you we need to have a space for both raw and finished water pumping. For the BH plant, the finished water number would be used to calculate approximate phosphate dosage, but the raw water number is needed for the alum. Depending on chlorine application points, you might use either/both. Attached is our current DRAFT template, which I will make a note to add finished water. Regardless, the above legal reference should be sufficient to justify the ACO finding and the project you are currently undertaking.

Thank you, and take care.

Ernie Sarkipato, P.E.
Surface Water Treatment Specialist
Drinking Water and Environmental Health Division
MI Department of Environment, Great Lakes, and Energy
616-307-0261 mobile



www.michigan.gov/drinkingwater

From: Mike O'Malley <momalley@cityofbentonharbormi.gov>
Sent: Wednesday, May 15, 2019 4:09 PM
To: Sarkipato, Ernest (EGLE) <SARKIPATOE@michigan.gov>; Bolf, Michael (EGLE) <BOLFM@michigan.gov>
Cc: Marcus Muhammad <mmuhammad@cityofbentonharbormi.gov>; Darwin Watson <dwatson@cityofbentonharbormi.gov>; Mike OMalley <momalley@cityofbentonharbormi.gov>
Subject: Reply demanded to be made Close of business today to Michael Bolf letter dated 04 01 2019 and addressed to Mayor Marcus Muhammad

Ernie,

I did not particularly know just who to follow up this email to.
I literally do not know a few of the EGLE people on the copy line.
And for some foolish reason, I thought not even the Director of EGLE DW and MAD.
The letter came from Michael Bolff? so he is included. to Mayor Mhhammad, so he is included. And emailed to Darwin and I , so included.
Since the letter is stating pretty much all plant stuff and S2, I felt compelled to respond.
And, frankly this was your best bet to get it today.
The dates are not dead on, but the activities described are what I believe you needed.
And, forgive me, but I made a brief exception to the ACO Metered Distribution Requirement, as I asked you about this morning.
I plan to continue with my calculated metering for OPP addition; until such time as we have an actual Suction line meter.
Note though:
Benton Harbor will need an extention for the metering requirement as it will take > 8 weeks for the actual meter to be built. and a little time to get a SCADA technician in to add the values.
Add to notes:
The Chlorine injection pump to raw water has been installed but the plugging problem at the intake has returned.
The Alum Supply Line is in and works very well to the re-purposed Polymer Tank.
The 1st Alum pump is here. I need a plumber to install it and the 2nd to arrive.
See Attached:*Reply to letter dated April 1 2019 City of Benton Harbor ACO Compliance Schedule.pdf*
Thanks,
Mike O'Malley
Benton Harbor Water Superintendent

R 325.11008 Complete treatment system; design and operation requirements.
Rule 1008. (1) A minimum of 2 units shall be provided for each treatment process for coagulation, sedimentation, and filtration.
(2) A sufficient primary coagulant dose shall be added to create a settleable or filterable floc at all times that a conventional filtration or direct filtration plant is in operation.
(3) Essential chemical systems for the application of disinfectants, primary coagulants, and other chemicals, as required by the department, shall be equipped to provide service at the maximum allowable treatment rate with the largest unit removed from service.
(4) Equipment provided for disinfection required under subrule (3) of this rule shall be capable of treatment at the rated treatment capacity with the largest unit removed from service.
(5) Application points for disinfection shall be provided, or be available, at all of the following locations:
(a) Before coagulation.
(b) Immediately preceding filtration.
(c) Immediately following filtration.
(d) Immediately before entry of finished water into the distribution system.
(6) Each unit or element of a complete treatment system shall be provided with a means to remove it from service without interrupting the treatment process. However, a complete bypass of the coagulation, sedimentation, or filtration processes is prohibited.
(7) Each unit or element of a complete treatment system shall be provided with a means to drain and with overflow control sufficient to prevent flooding of the facility.
(8) Common walls between finished water and water of lesser quality are prohibited.
(9) Each complete treatment system shall be provided with a means to measure the volume and rate of raw water supplied and finished water produced.
(10) A complete treatment system shall be protected from the highest recorded flood elevation or the 100-year flood elevation, whichever is greater.
(11) Components of a complete treatment system which are essential for the protection of the public health and which are required for the production of drinking water on a continuous basis shall be protected from flooding.

History: 1979 AC; 1991 AACS; 2003 AACS.

R 325.11009 Rescinded.
History: 1979 AC; 2003 AACS

MONTHLY OPERATION REPORT OF
WATER TREATMENT PLANT

SUPPLY NAME: _____
WSSN:

Operator-in-Charge | Month/Year

Certification of Operator-in-Charge | Water Plant Classification

Signature of Operator-in-Charge | County

Treatment Rate and Filter Data

Maximum Treatment Rate:	_____	Million Gallons per Day
Rated Plant Firm Capacity:	_____	Million Gallons per Day
Average Filter Run:	_____	Hours
Average Head Loss:	_____	Feet
Average Filtration Rate:	_____	Gallons Per Square Foot per Minute
Maximum Filtration Rate:	_____	Gallons Per Square Foot per Minute
Average Wash Water Use:	_____	Percent of Treated Water

Chemical Data

Chlorine on hand:	_____	gals.	Est. supply: _____	days
Primary Coagulent (Alum/Poly) on hand:	_____	gals.	Est. supply: _____	days
Cost of All Chemicals per Million Gallons:	_____	dollars		
Total Power Cost per Million Gallons:	_____	dollars		

Remarks

Number of filter confluence samples > 0 .3 NTU:	_____
Number of filter confluence samples collected:	_____
Percent of filter confluence samples > 0 .3 NTU :	_____

Filter Operations

Was each filter monitored continuously	YES
If no, attach specific filter(s) information and indicate required follow-up status.	
Were measuremnts recorded every 15 minutes	YES
If no, indicate cause and follow-up status and grab sample schedule.	
Was there a failure of the continuously monitoring equipment?	NO
If yes, indicate cause and follow-up status and grap sample schedule.	
Was individual filter level greater than 1.0 NTU in two consecutive measurements	NO
If yes, indicate date(s) and duration.	
Was individual filter level greater than 0.5 NTU in two consecutive measurements after on line for more than four hours	NO
If yes, indicate date(s) and duration.	
Was individual filter level greater than 1.0 NTU in two consecutive measurements in three consecutive months	NO
If yes, indicate date(s) and duration.	
Was individual filter level greater than 2.0 NTU in two consecutive measurements in two consecutive months	NO
If yes, indicate date(s) and duration.	

Chlorination

Did POE disinfectant residual fall below 0.2 ppm during the month?	NO
If yes, indicate date(s) and duration on a separate sheet.	
Was minimum C*T credit achieved for the entire month?	YES
If no, indicate on a separate sheet the date(s) not achieved.	

COMMENTS:

Coagulation Parameters **Supply Name** _____ **Mth/Yr** _____ **Page 2**

WSSN

				Turbidity, Units													
				Raw			Applied	Individual Filters			Filter Confluence						Plant tap
DATE	Million Gallons Treated	Coagulant	Coagulant Applied	Number of Samples	Avg.	Max.	Applied Avg.	Max	Max after 15 min	Filter No.	Number of Samples	Avg.	Max	No. of 4 Hr. Compliance periods	No. of 4 Hr. Compliance periods > 3 NTU	No. of Samples >0.3 NTU	Plant tap NTU
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
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31																	
AVG	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
MAX	0.000	0.0	0 00	0	0.00	0 00	0.00				0	0.00	0.00	0	0	0	0.00
MIN	0.000	0.0	0 00	0	0.00	0 00	0.00				0	0.00	0.00	0	0	0	0.00
TOTAL	0.000	0.0									0			**0**			

FLUORIDATION AND CHLORINATION **SUPPLY** _____ **WSSN** **Mth/Yr** _____

DATE	Fluoride Application		Fluoride Analyses mg/l			Chlorine Application mg/l					Chlorine Residual mg/l							
	Fluoride	Fluoride Applied (mg/l)	Raw	Tap	Dist.	Chlorine	Pre-Chlorine	Inter-mediate Chlorine	Post Chlorine	Total Chlorine	Mixing Chamber		Applied		Filtered		Tap	
											Free	Total	Free	Total	Free	Total	Free	Total
1																		
2																		
3																		
4																		
5																		
6																		
7																		
8																		
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AVG	#DIV/0!	#DIV/0!		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!				#DIV/0!		#DIV/0!					
MAX	0.0	0.00		0.00	0.00	0 0	0 00				0.00		0.00				0 00	
M N	0.0	0.00		0.00	0.00	0 0	0 00				0.00		0.00				0 00	
Total	0.0					0 0												

Percent Fluoride Purity: 23.46 %

Percent Available Chlorine : 15 %

CHEMICAL ANALYSES **Supply** **Mth/Yr:**
WSSN:

	pH		Total Hardness Test		Total Hardness as $CaCO_3$ mg/l		Total Alkalinity as $CaCO_3$ mg/l		Non - Carbonate Hardness as $CaCO_3$ mg/l			Calcium as Ca^{++} mg/l		Magnesium as Mg^{++} mg/l		Chloride as Cl- mg/l		Sulfate SO_4- mg/l	
DATE	Raw	Tap	Raw	Tap	Raw	Tap	Raw	Tap	Raw	Tap	Tap	Raw	Tap	Raw	Tap	Raw	Tap	Raw	Tap
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
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AVG	#DIV/0!	#DIV/0!			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!									
MAX	0.0	0.0			0.0	0.0	0 0	0.0	0.0	0.0									
MIN	0.0	0.0			0.0	0.0	0 0	0.0	0.0	0.0									

BACTERIOLOGICAL AND PHYSICAL PARAMETERS

Supply: _____ **Mth/Yr:** _____

WSSN: _____

DATE	Total Coliform				Standard Plate Count		Wind Direction	Temp. °C	Color True __ Apparent X		Odor Cold X 60 C		Comments
	Raw		Plant Tap										
	Pre.	Abs.	Pre.	Abs.	Raw	Tap			Raw	Tap	Raw	Tap	
1													
2													
3													
4													
5													
6													
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26													
27													
28													
29													
30													
31													
AVG.													
MAX								0.00					
MIN								0.00					

DISTRIBUTION SYSTEM MONITORING

Supply:

WSSN:

DATE	Chlorine Residual at Bacteriological Monitoring Stations (mg/l)							
	# 1	**Bacti Result**	**# 2**	**Bacti Result**	**# 3**	**Bacti Result**		
1								
2								
3								
4								
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8								
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31								
MOTHLY AVERAGE RESIDUAL								
Monthly Max Residual								
Monthly Min Residual								

WSSN:
Mo./Year:

Comments:

Solutions and Calculations:

Weight of Water
Million gallons of treated water x 8.34 = million pounds of treated water

Chlorine

Phosphate

Fluoride

GRETCHEN WHITMER
GOVERNOR

STATE OF MICHIGAN
DEPARTMENT OF
ENVIRONMENT, GREAT LAKES, AND ENERGY
GRAND RAPIDS DISTRICT OFFICE

LIESL EICHLER CLARK
DIRECTOR

July 2, 2019

Mr. Darwin Watson, City Manager
City of Benton Harbor
200 East Wall Street
Benton Harbor, Michigan 49022

WSSN: **00600**

Dear Mr. Watson:

SUBJECT: **REVISED**: Administrative Consent Order: Progress Update and Revised Schedule

This letter is in response to a discussions with Benton Harbor staff regarding the compliance schedule established in the Administrative Consent Order (ACO) effective March 5, 2019. Extensions for Section II - Compliance Schedule (Compliance Schedule) of the ACO were granted on April 1, 2019 and on May 16, 2019. On June 20, 2019, the Department of Environment, Great Lakes, and Energy (EGLE) received another request for extensions of additional items in the Compliance Schedule. EGLE staff would like to acknowledge the competing timelines in the Compliance Schedule by spreading out the deadlines, and also reiterating the terms of the ACO.

Allowing sufficient time to complete tasks in the Compliance Schedule is necessary; however, timely implementation of items that will directly result in greater protection of public health must be prioritized. The table below includes an updated Compliance Schedule that satisfies the recent extension request from the City of Benton Harbor and sets interim deadlines for items requiring permitting.

Item	Initial Deadline	Extended Deadline	Status/Comment
Submit a rate study	4/1/2019	(completed)	
Submit plan to implement rate increases	4/1/2019	9/30/2019	
Upgrade SCADA system for data access and storage	4/1/2019	5/15/2019	(completed)
Install flow meter on finished water	4/1/2019	9/30/2019	Permit issued, waiting for manufacturer
Install continuous chlorine analyzer on WTP tap	4/1/2019	5/15/2019	(completed)
Distribution Operator in charge	4/1/2019	5/22/2019	(completed, need contract)
Corrosion Treatment Study	4/1/2019	(completed)	
Submit updated rate collections plan	5/1/2019	9/30/2019	
Updated cross connection program including residential accounts	6/1/2019	12/31/2019	
Permit and Construct coagulant feed to existing rapid mix	6/1/2019	8/30/2019	Submit permit application by 7/31/2019

Item	Initial Deadline	Extended Deadline	Status/Comment
Submit maintenance plan for valves and hydrants	6/1/2019	9/30/2019	
Conduct professional inspection of water tower	6/30/2019	12/31/2019	Not necessary if repainting is planned
Install/repair mussel control system at intake	6/30/2019	12/31/2019	Submit permit application by 11/29/2019
Repair filter to waste valves	1/31/2020		

Be advised that, per Paragraph 1.3 of the ACO, the City of Benton Harbor remains obligated to pay stipulated penalties of $500 per violation per day for failure to comply with a specific deadline set forth in the Compliance Program, including the extended deadlines set forth above.

It is our intention to work with you on resolving these issues in a timely manner. We anticipate and appreciate your cooperation in working together to resolve these matters. Additionally, if you have any questions regarding this Violation Notice, please contact me below or at sarkipatoe@michigan.gov.

Sincerely,

Ernie Sarkipato, Surface Water Treatment Specialist
Grand Rapids District Office
Drinking Water and Municipal Assistance Division
616-307-0261

cc: Mr. Mike O'Malley, Water Superintendent, Benton Harbor
Mr. Mike Bolf, P.E., Engineering Unit Supervisor, DEQ (via email)
Ms. Maureen Nelson, Enforcement Specialist, DEQ (via email)