Sanitary Survey
Evaluation Form

Basic Data

Name of Supply: City of Benton Harbor

WSSN: 0600

Review Dates: March 24, 2010, July 28, 2010, December 2, 2010, March 10, 2011, April 27, 2011, June 15, 2011, August 18, 2011

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 Ridgeway
St. Joseph, MI 49085

Phone: (269) 927-8471
Fax: (269) 927-8469

City Officials:
Mayor: Wilce Cook
Emergency Financial Manager: Joseph Harris
City Manager: vacant
Utilities Director: Darwin Watson dwatson@bhcity.org (269) 927-8445
Deputy Utilities Service Director: Mike O'Malley momalley@bhcity.org (269) 487-1238 cell
Operator-In-Charge: Mike O'Malley
Designated Backup Operator: Frank Huff
Distribution System Superintendent: Thomas Spitzner

Water Treatment Plant Operators:

	Name	Licenses	Operator ID
1.	Mike O'Malley	F-1, S-1	2634
2.	Frank Huff	F-2, S-3	3258
3.	Doug Vanderploeg	F-3, S-3	2171
4.	Denny Edwards	F-4, S-4	4753
5.	Darwin Watson	F-4, S-4	4710

Retail Customers:	Name	Population
1	City of Benton Harbor	10,038 (2010 census)
2	St. Joseph Charter Township	~ 2,700

Wholesale Customers	None

Total Population Served: 12,738

Percent Metered: City – 100%, St. Jo. Twp – 100%,

Percent Unaccounted: ~ 10 % (per Abonmarche DWRF project plan)

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.

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) Water Plant is classified as an F-1 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. O'Malley has an F-1 license and the City is encouraged (not required) to have at least one other operator with an F-1 license. Currently, the City adequately meets the certified operation and oversight requirements. The existing plant staff are well trained and current in continuing education.

The plant is not locked during normal business hours. A door buzzer alerts staff during after hour deliveries. No trespassing signs are posted in front of the plant, and an entry gate and permiter fencing has been installed.

Pumpage Data (Million Gallons)	2004	2005	2006	2007	2008	2009	2010
Maximum Daily Demand:	7.29	8.31	7.69	8.91	7.26	7.23	6.67
Average Day For Maximum Month:	5.72	6.57	5.93	6.27	6.11	4.94	4.04
Average Day Demand For Year:	4.59	4.68	4.42	4.55	4.83	4.41	3.96
Minimum Day Demand	1.2	3.0	2.9	2.7	3.2	2.7	2.2
Average Per Capita Consumption: (gpd)	222	226	214	219	233	213	191

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: 30%

Emergency Supply/Interconnection: yes (capacity undefined)
one interconnection with the City of St. Joseph at M-63 (metered 16-inch main)

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 City is currently undergoing a DWRF water plant rehabilitation project that includes the replacing the old filter underdrains and filter wall repair. Original plant capacity will be restored upon project completion.

The 2.65 MG of total treated water storage is 43% of average day demands and 30% 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. This separation has resulted in a reduction in the City retail customer population by approximately 30 percent. Consequently the Euclid standpipe and M-139 ground reservoir may no longer be available for the City to depend on. 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 can be 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 and City of St. Joseph interconnections should be obtained.

Water Quality

Data taken from the 2009 & 2010 Monthly Operation Reports

	Raw		Treated	
	Normal	Range	Normal	Range
Hardness, ppm	140-175	130-207	135-170	127-206
Turbidity, NTU	3.60-6.05	0.88-89	0.11-0.12	0.09-0.21
Alkalinity, ppm	104-132	82-174	91-115	79-202
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	<0.4-0.9
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	7.7-8.2	6.9-8.5	7.0-7.2	6.6-7.7

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. Quick thermal changes can result in high applied turbidities and filtered water in excess of the turbidity 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. The slight alkalinity variation does not affect treatment capabilities, or allow large pH changes. The pH does change somewhat in the raw water with limnologic conditions, but is fairly consistent in the treated water.

Natural raw water fluoride levels are characteristic of the Lake Michigan geologic basin and can vary by as much as 0.7 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. Occasional equipment failure may cease fluoridation, for as long as several weeks. The water plant project will be replacing fluoride feed equipment with a more reliable feed system.

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. It is expected that the City will comply with the Locational RAA levels under this rule.

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 (1964)
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?	No: valve on backflush line has been physically removed

Comments on Intake: The intake and two emergency risers are generally inspected every two years, but was last done in 2008. Both the intake and the risers are reported to be in good condition. Currently, chlorine is being fed at the intake to control zebra mussels. 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 and the WTP does not have the capability to back flush the intake.

The wet well was last cleaned and inspected in 2005.

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	active	annually	no
	Firm		14 MGD					
High Service:			(MGD)					
	#1	plant – 2nd floor	2.0	vertical turbine	oil	active	annually	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	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**	**surface**	**water**	

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 during the survey. 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, 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 55º inclination
Clarification Rate (gpm/sq. ft.) 0.3 gpm/ft²
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
Physical Condition: new
Effluent Turbidity, average/range: ~ 0.4 - 1.0

Clarifier Comments: The old Accelators have been removed from service at the time of this report, and replaced with new stainless steel plate settling basins. The old Accelators were very susceptible to thermal inversions which can cause upsets in the sludge blanket and caused high turbidity levels (up to 25 NTU) in the applied filter water. The old Accelators were also old and rusted, and had exceeded their useful service life.

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 to surface water without an NPDES permit. A newly constructed backwash lagoon berm failed and is being redesigned.

There is a continuous reading turbidimeter on the common effluent pipe from both basins. At the time of this survey, the settled water quality was excellent. 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 9, 10, 11, & 12, were out of service at the time of the DEQ inspection

Design Filtration Rate, gpm/ft^2: 1MGD per filter (2 gpm/ft²)

Approved Filtration Rate, gpm/ft^2: 4 gpm/ft² on clean filter, 2-2.5 gpm/ft² over entire filter run

Maximum Experienced Filtration Rate, gpm/ft^2: 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: 105 Maximum: 120 Minimum: 8

Summer Average ~ 70 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 – under construction during DEQ visit

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

Curbing: front of all filters, not on catwalk (back perimeter)

Filter Overflow: back to settling basins

Surface Wash: filters 1-8 working, filter 9-12 under construction 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 and were offline at the time of the DEQ inspection. 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 9 and 10 were backwashed during inspection. The spray arm wash was still buried in filter media from construction. The filter apparently cleaned up nicely. A backwash valve however did not seat all the way, causing water to overflow the adjacent filter and flood the filter room and filter gallery with a few inches of water. The backwash valves were then inspected and adjusted for proper operation.

The on-line turbidimeters were recently replaced with 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: ~ 105 hours

Criteria for Backwash: 120 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 no

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 – yes, in new filters
Adequate Backwash Rate - yes	Mudballs - no

Filter Operation Comments: The filters are backwashed at a maximum of 120 hours, 1.0 gpm/sq.ft or 0.3 NTU, which ever comes first. The 120 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 when 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 only been in service a few months, so filter run times may be improved with satisfactory plant operation.

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 operation.

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 elevation?

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. The vent screens were loose during the DEQ inspection with large gaps between the vent and the screened cap, but have since been tightened.

The 12-inch isolation valve was recently replaced to allow isolation of the reservoir halves.

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 %

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* and rapid mixer
3) applied – each settling basin effluent
4) treated – high service pump discharge header*

*normal feed points

Chlorinators

Type of Feeders: Capital Control Vacuum feeders

Location of Vacuum Regulators: on chlorine cylinders in chemical storage building

	Location	Maximum Feed Rate
1)	Raw water (low service discharge)*	500# / day
2)	flash mixer	200# / day
3)	intake	500# / day
4)	treated (high service discharge)*	100# / day

* chlorine feed points normally used

Chlorine Feed Dosage Determination: prechlorine residual in filters > 1.2 mg/l

postchlorine residual in reservoir > 1.3 mg/l

Chlorine Room Description: Bulk chlorine storage room is located south of the plant. Chlorine gas is transported to 4 vacuum chlorinators located in chlorine feed room on the 2nd floor.

Scales: yes

Minimum Days of Storage: ~ 60

Gas 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)

☐ Air Pack	☒ Panic Hardware
☐ Respirators	☐ 1st Responders
☒ Chlorine Leak Alarm	☒ Haz-Mat Team
☒ Leak Detection Bottle	☒ Inside Access feed room only
☒ Cylinder Restraint	☒ Outside Access yes - both
☒ Doors Open Outward	☒ Repair Kit
☒ Heater	☒ Ventilation
☒ Window	☒ Air Supply
☒ Scales	☒ Fan Switches

Chlorine Comments: Construction of the bulk storage building in 1989/1990 led to significant safety improvements in the chlorine feed system. The east end of the bulk storage building contains up to 8 ton cylinders and is equipped with required safety appurtenances, although it is questionable if the

overhead door has a tight seal to prevent leaks. Gas is fed (under vacuum) to four vacuum chlorinators in the plant (with concentric piping in occupied areas) which are equipped with flow meters that limit the capacity of the chlorinator system to 500 pounds per day, which would deliver 5 ppm at rated plant capacity of 12 MGD

There are separate feed systems for pre and post chlorination, with an RPZ on both lines. However, there appears to be a possible cross connection between chlorinator No. 3 (raw water) and No. 4 (finished water). There is still apparently an interconnect pipe between the effluent pipes of these two chlorinators which could allow raw water to be siphoned to finished water under the proper conditions. This interconnect pipe must be removed or cut.

*Haz-Mat team responds to ALL chlorine leaks.

The water plant recently switched to liquid chlorine. The bulk liquid chlorine feed system was under construction at the time of this survey.

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: Fluorosilic acid (H2SiF6), 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.

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 constructing polymer addition for the plate settlers. The plate settler manufacturer recommends the use of polymer to the plate settlers.

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 OUT OF 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 being 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? RPZ on boiler make up line

Comment on Plant Piping Miscellaneous: Piping is currently being 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 or dehumidifier in the plant.

There is an interconnect pipe between the effluent pipes of chlorinators No. 3 and No. 4 which is a possible cross connection between the raw and finished water. This interconnect pipe must be removed or cut.

All filter wash hoses should be replaced and 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:

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 after 5 pm.

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	☐ CFE Turbidity
☒ Chlorine Leak	☐ Backwash Holding Tank
☐ Chlorine Supply	☐ Main Control System Failure
☒ Low Service Intake Well	☐ Transfer Well
☐ Pretreatment Basin Levels	☒ Finished Water Reservoir
☒ Elevated Storage Tanks	☐ Individual Filter Turbidity
☒ Filter Level	☐ Elevated Tank Loss Of Signal
☒ High Service Pump Discharge Pressure	
☐ Pretreatment Sump Pump Failure	

Comments on Plant Metering and Controls: The raw water, plant domestic water and treated water meter all have totalizers which are read every day at midnight. 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 is being 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 2100n/1720C Hach 2100n/1720C Hach 1720E Hach 2100n/1720C Hach 2100n/1720C	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, 2012.

Comments on Laboratory: The laboratory is inspected by DEQ Remediation and Redevelopment Division before a new lab certification certificate is issued, however the state-issued lab certificate is not on display and may have been lost during the construction project.

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. The majority of the plant was constructed in 1950, with several improvement projects completed since the original plant went on-line. Since the last sanitary survey was completed in 2007, the City has abandoned the old clarifiers (Accelators), constructed plate settlers in two separate treatment trains, installed 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 is currently constructing a backwash lagoon for backwash disposal, and converting to liquid chlorine

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. 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 would have had to follow the TTHM and HAA5 sampling protocol specified starting in October, 2013. However with the loss of customer base when the township customers left, the City must redo their sampling plan as the sampling locations are now no longer part of the City distribution system.

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.

Under the current DWRF project, the City is switching completely to SCADA for monitoring just about all aspects of plant operation. When the SCADA system is fully operational the capability to operate the plant manually must be maintained for reliability.

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.

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.

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 will have the capability to add both polymer and alum in the near future. The new pretreatment process has only been on line for a few months, but 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 is undergoing a capital improvement project which is replacing all the filter influent and filter drain valves located in the filter piping gallery and have 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 chemical storage (six 8-ton gas cylinders) located in a separate building and 4 vacuum 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 chlorine feed system utilizes a vacuum regulator connected to the chlorine cylinders to prevent major loss of chlorine if a leak in the feed system is developed.

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 1.3 mg/l.

Both the bulk storage building and the feed room within the plant have adequate safety features including leak alarms, panic hardware, viewing windows and ventilation. All leaks are responded to by the Berrien County Haz-Mat team. Operators are no longer allowed to repair leaks.

The City is in the process of switching to liquid chlorine. A bulk tank has been permitted and installed.

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 bi-annual 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.

There is one 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.

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 the new backwash lagoon for backwash disposal operation.
2. Continue and finish the DWRF funded water treatment plant project.
3. Update the bactieriological sampling site plan, the Disinfection By-Product Rule Stage I and II monitoring plans, and lead copper sites prior to the next perspective monitoring period due dates.

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 missing basin.
3. Start inspecting the finished water reservoir comprehensively on a regular basis, say every five years.
4. Obtain Water treatment Plant as-built drawings and submit them for state record.

SANITARY SURVEY EVALUATION FORM

DISTRIBUTION SYSTEM

GENERAL

Primary Contact: Tom Spitzner
Title: Distribution Foreman
Telephone:
Cell Phone: 269 363 7625
Pager:
Fax: 269 927 8469
e-mail: tspitzner@bhcity.org
Mailing Address:
200 East Wall Street
PO Box 648
Benton Harbor, MI 49023-0648

Copy To: Darwin Watson
Title: Utility Director
Telephone: 269 926-6663
Cell Phone:
Pager:
Fax: 269 927-8469
e-mail: DWATSON@bhcity.org
Mailing Address:
200 East Wall Street
PO Box 648
Benton Harbor, MI 49023-0648

Population: 12,738 Year: 2010 Basis: census plus estimate form township account

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

Operator Certification

Distribution Classification: S-2

Operator-in-Charge: Tom Spitzner	Cert: S-1, D-1	Oper ID: 1885
Designated Back-Up: John Davis, Dist. Crew Chief	Cert: S-4	Oper ID: 6066
Other Operators: Darwin Watson	Cert. S-3 / F-4	Oper ID: 4710
Denny Edwards	Cert. S-4 / F-4	Oper ID: 4753
Kaye Jenkins	Cert. S-4	Oper ID: 5236
Garyl Guidry	Cert. none	Oper ID: 13773
Idell Potts	Cert. none	Oper ID: 16846
Albert Moore	Cert. none	Oper ID: 14906
JT Suttles	Cert. none	Oper ID: 7516
Eddie Ellis	Cert. none	Oper ID: none
Eddie Davis	Cert. none	Oper ID: 13771

Ownership

Ownership: City – council / manager

Consent Agreement: NA

Escrow Account: NA

Annual Fee: active

Comments: Joseph Harris, EFM

Current Emergency Financial 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	
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: ~ 42% Storage/Avg. Day: ~ 78%

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

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.

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 upon completion of DWRF distribution work. City should plan for elimination of all undersized and lead main.

Pump Stations

Location: Grand Blvd

Function: Boost Pressure

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	2006	2006
Last Efficiency Test	2006	2006

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.

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 recently to replace the old 1968 generator. Load testing is now being performed regularly.

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? seldom

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 McCalister 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? no

If yes, list locations:

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:
McCalister – replace lead main	unknown

Comment on Capital Improvements, ISO Rating: Fire flows tested frequently. City intends to pursue project to replace 4-inch main with sewer upgrades.

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. 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: 100%

Identify service line materials and estimate percentages:

Copper: 30 %

PVC/PE: 0%

Galvanized: 70 %

Lead: ? % **lead services are common 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. 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 and rarely prosecuted. Many water bills are in arrears. Poor customer metering practice is resulting in lost revenue for the water system.

Water Rates

What is your current rate schedule? $2.16/100 ft³ (or $2.89/1,000 gallons)

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

When was last time rates were adjusted? 2009

Has a water rate study been performed? When?

Is there a meter charge or ready to serve charge? yes

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 does not have meter rental policy for contractor hydrant use. 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)? LATE

Inspection Status:

Device Testing Frequency:

Recordkeeping Adequate? no

Comment on Cross Connection Program: Hydro Designs was under contract for cross connection administration in recent years. The City intends on performing the inspections with staff, but training is needed. Most city-made inspections are made in response to water complaints or high bills.

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)

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

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.

Reliability Study

Date of Most Recent Study: 3/27/2008 Acceptable? yes

Filed Where?

Comment on Reliability Study: Next Reliability Study due in 2013.

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): no

Updates general plans (Y/N): no

Bacteriological

Date of Approved Site Sampling Plan: March 2005

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

MCL, Monitoring or Reporting Violation(s)? (Y/N) yes

Number & Type of Violations in past 12 months: 1 non-acute MCL

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

Bacti Plan Comments: Bacteriological samples are being collected in accordance with the approved Sampling Site Plan (Plan). The Plan needs to be modified to reflect the current township customers.

Chemical

Date of Monitoring Schedule: 2011

If nitrite detect, what is concentration? NA

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

Metals (list):

Detects for VOCs (Y/N) only DBPs within normal ranges 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 2012

Corrosion Control Program, if applicable: NA

Lead service line replacement status, if applicable: NA

Chemical Monitoring Comments: Lead/copper sampling must be repeated for failure of taking all the required samples last year. 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 adjacent water supplies 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
3. Inventory and assess all hydrants.
4. Develop emergency use agreements with nearby water supplies.
4. Start comprehensive cross connection inspections according to program.

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. Schedule a comprehensive inspection of the elevated water tower.

Evaluation of Community Water Supply - Water System Review Summary

Name of Supply: City of Benton Harbor WSSN: 0600

County: Berrien District: 52

Evaluator: Gary Wozniak, P.E. Date: August 18, 2011

Overall Rating: Satisfactory: ☐ Marginal: ☒ Deficient: ☐

		N /A	Sat.	Marg.	Def.
General					
	Operator Certification	☐	☒	☐	☐
	Ownership	☐	☒	☐	☐
Source					
	Intake Construction & Maintenance	☐	☒	☐	☐
	Standby Power	☐	☒	☐	☐
	Isolation	☐	☒	☐	☐
	Capacity	☐	☒	☐	☐
Storage					
	Construction	☐	☐	☒	☐
	Controls	☐	☒	☐	☐
	Maintenance	☐	☐	☒	☐
	Capacity	☐	☒	☐	☐
Distribution					
	Interconnections with other Supplies	☐	☐	☐	☒
	Pump Stations	☐	☒	☐	☐
	Operational Concerns & Maintenance	☐	☐	☒	☐
	Hydrants	☐	☐	☐	☒
	Valves	☐	☐	☐	☒
	Customer Service Information	☐	☒	☐	☐
	Meters	☐	☐	☐	☒
Program Compliance					
	Cross Connections	☐	☐	☒	☐
	Annual Pumpage Reports/MORs	☐	☒	☐	☐
	CCR	☐	☒	☐	☐
	Emergency Response Plan	☐	☒	☐	☐
	General Plan	☐	☐	☒	☐
	Reliability Study	☐	☒	☐	☐
	Permits	☐	☒	☐	☐

		N /A	Sat.	Marg.	Def.
	Capacity Development - Financial	☐	☐	☐	☒
Monitoring					
	Bacteriological	☐	☒	☐	☐
	Chemical	☐	☒	☐	☐
	Lead/Copper	☐	☐	☒	☐
	Radiological	☐	☒	☐	☐
	DBPR	☐	☒	☐	☐
Treatment					
	Disinfection	☐	☒	☐	☐
	Pretreatment	☐	☒	☐	☐
	Fluoride	☐	☒	☐	☐
	Filtration	☐	☒	☐	☐
	CT	☐	☒	☐	☐
	Chemical Addition	☐	☒	☐	☐
	High Service Pump Capacity	☐	☒	☐	☐
	Control Systems	☐	☒	☐	☐
	Analytical Capabilities	☐	☒	☐	☐
	Maintenance	☐	☒	☐	☐

APPENDICES

APPENDIX A

Plant Flow Diagram

APPENDIX B

2011 Monitoring Schedule
Chemical Sample Results
Trihalomethane (TTHM) Averages
Haloacetic Acid (HAA5) Averages
Total Organic Carbon Removal Averages

APPENDIX C

C*T Calculations

APPENDIX D

Treatment Optimization Recommendations

Appendix E

Pertinent Correspondence

Appendix F

Survey Photos

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

Sanitary Survey
Evaluation Form

Basic Data

Name of Supply: City of Benton Harbor

Review Dates: February 26, 2015,
April 16, 2015, June 16, 2015

WSSN: 0600

Reviewed By: Gary Wozniak, P.E.

Mailing Address:
City of Benton Harbor
200 East Wall Street
Benton Harbor, MI 49022

Plant Address
Benton Harbor WTP
601 North Ridgeway Drive
St. Joseph, MI 49085

Phone: (269) 927-8400
Fax: (269) 927-0304

Phone: (269) 927-8471
Fax: (269) 927-8469

City Officials:
Mayor: James Hightower

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

Utilities Director: Stewart Beach
(269) 363-0575 cell
sbeach@cityofbentonharbormi.gov

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

Total Population Served: 10,038

Percent Metered: City – 100%

Percent Unaccounted: ~ 40 %

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.

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)
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 (MGD)					
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 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.

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 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

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*

2) raw water - rapid mixer

3) applied – each settling basin effluent

4) 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 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, 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 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.

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.

SANITARY SURVEY EVALUATION FORM

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

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

SANITARY SURVEY EVALUATION FORM

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 ft^3 (or $5.08/1,000 gallons)

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 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.

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.

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

APPENDIX B

2015 Monitoring Schedule
Chemical Sample Results
Trihalomethane (TTHM) Averages
Haloacetic Acid (HAA5) Averages
Total Organic Carbon Removal Averages

APPENDIX C

C*T Calculations

APPENDIX D

Treatment Optimization Recommendations

Appendix E

Pertinent Correspondence

Appendix F

Survey Photos