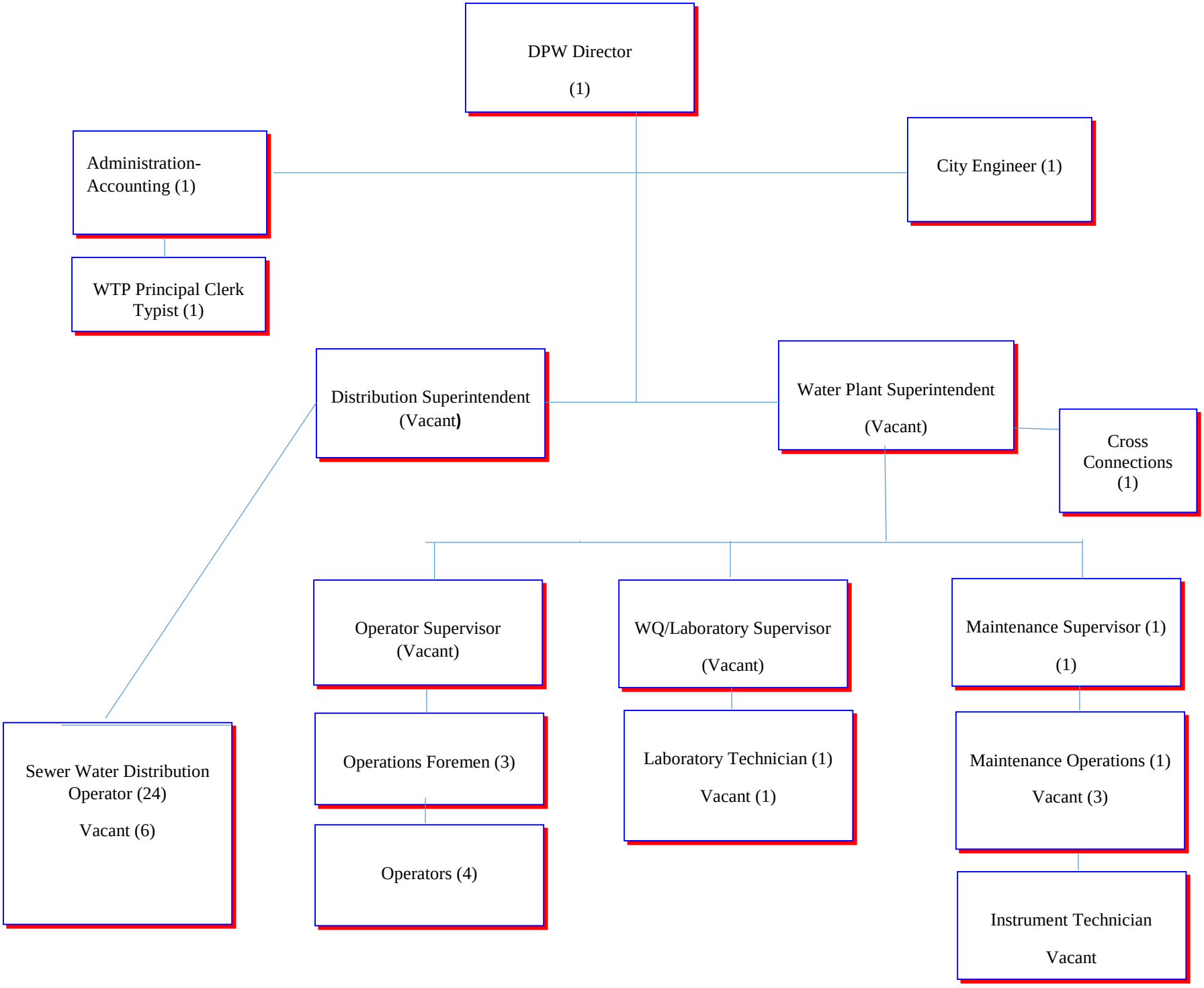
UTILTIES WATER DIVISION



STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
SAGINAW BAY DISTRICT OFFICE

RICK SNYDER
GOVERNOR

C. HEIDI GRETHER
DIRECTOR

December 13, 2017

Mr. Robert Bincsik, Director
City of Flint Department of Public Works
3310 East Court Street
Flint, Michigan 48506

Dear Mr. Bincsik:

SUBJECT: Interim Water Quality Parameters, WSSN: 02310

This letter provides revised information regarding the collection and reporting of water quality parameter (WQP) samples on an interim basis from the city of Flint's supplemental water treatment facility and distribution system. The adjustments to the city's supplemental chemical feed systems are based on the corrosion control study released by Cornwell Engineering Group. The proposed WQP program is intended to assist our joint effort to establish final WQPs and provide transparent evidence of the water quality provided to city residents.

WQP samples are required under the Lead and Copper Rule (LCR); therefore, these samples will be used to determine compliance. The required monitoring may be periodically modified based on the results produced by the program. Also, the WQP sampling program may be changed after the final corrosion control study report is released in 2018 or 2019; however, you must continue to monitor according to the schedule already in effect until you are otherwise notified by the DEQ.

This revised WQP sampling program leaves the current weekly Enhanced Water Quality Monitoring (EWDM) program in place. The location, parameters and frequency for the monitoring will remain the same. However, there are minor adjustments to the required distribution system phosphate and pH ranges as shown below:

Parameter-EWDM Sampling Stations	Target*	100 percent range**
pH (standard units)	7.5	7.2 – 7.9
Orthophosphate residual (mg/l)	3.3	3.1 – 4.5

* The target value is an operational goal only for your water system. Failure to meet the target value will not result in violations. ** The 100 percent range is a required operating range for your water system. One hundred percent of your monthly sample results must fall within the 100 percent range for each parameter, except that nine (9) excursion days are allowed during each six (6) month WQP monitoring period. An excursion day is a day during which one or more result is outside the allowable range.

The major program change is the setting of WQPs at the point of entry for the city's supplemental water treatment facility. The values established for the water treatment facility are based on the pH, orthophosphate, and chlorine residual values needed over the past 1½ years to meet distribution system water quality goals. The intent is to set well-defined treatment

to meet distribution system water quality goals. The intent is to set well-defined treatment facility goals or targets for the city's operational staff to more consistently meet the distribution system WQP values. The following WQP targets and ranges are established for the point of entry to the distribution system (water plant tap):

Parameter-Water Treatment Facility	Target*	90 percent range*	100 percent range**
pH (standard units)	7.5	7.3 – 7.8	7.2 – 7.9
Orthophosphate residual (mg/l)	3.6	3.3 – 4.0	3.2 – 4.5
Free chlorine residual (mg/l)	1.5 – 1.8	1.4 – 1.9	1.3 – 2.0

* The target and 90 percent range values are operational goals only for your treatment system. At least 90 percent of your daily values for each month should fall within the 90 percent range for each parameter. Failure to meet the target and 90 percent range goals will not result in violations. ** The 100 percent range is a required operating range for your treatment system. One hundred percent of your daily values must fall within the 100 percent range for each parameter, except that nine (9) excursion days are allowed during each six (6) month WQP monitoring period. An excursion day is a day during which one or more daily value is outside the allowable range. "Daily value" means the average of all samples collected during a day at a single location.

The WQP results must be electronically submitted to the Department of Environmental Quality (DEQ). Essentially, the city will continue to submit a daily and monthly report for the treatment facility and a weekly EWDM summary for the distribution system.

If there are any comments or questions, please contact me.

Sincerely,

Bob London

Robert London, P.E.
Surface Water Treatment Specialist
Engineering Unit
Drinking Water and Municipal Assistance Division
989-450-7834

cc: Genesee County Health Department
Robert Jones, F and V Operations
Thomas Speth, USEPA ORD
USEPA Region 5
Via email: Eric Oswald, DEQ
George Krisztian, DEQ
Jon Bloemker, DEQ
Brian Thurston, DEQ

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING DISTRICT OFFICE

RICK SNYDER
GOVERNOR

DAN WYANT
DIRECTOR

October 30, 2015

VIA E-MAIL and U.S. MAIL

Mr. Mike Glasgow
Utilities Administrator
City of Flint
4500 North Dort Highway
Flint, Michigan 48505

Dear Mr. Glasgow:

SUBJECT: Water Supply – City of Flint (City) – Corrosion Control Treatment Operation

The purpose of this letter is to outline additional requirements and recommendations regarding the additional corrosion control treatment measures being taken by the City water system.

The City has been purchasing drinking water from the Detroit Water and Sewerage Department (DWSD)/Great Lakes Water Authority (GLWA) since Friday, October 16, 2015. DWSD/GLWA provides corrosion control treatment to its water and DWSD/GLWA has been deemed by the Michigan Department of Environmental Quality (MDEQ) to have fully optimized corrosion control treatment. This optimization requires DWSD/GLWA to provide orthophosphate addition, maintain a minimum dose of 0.9 milligrams per liter (mg/L) as PO_4, and maintain a DWSD/GLWA plant tap residual of 0.8 mg/L as PO_4. As part of its optimization, DWSD/GLWA is also required to maintain a minimum pH of 7.0 at the DWSD/GLWA plant tap.

Corrosion Control Treatment and Operation

To further enhance pipe passivation in the City water distribution system, customer service lines, and customer plumbing, **the City shall dose additional orthophosphate to increase distribution system phosphate residual to a minimum of 3.1 mg/L as PO_4 (1.0 mg/L as P).** The City has obtained a Michigan Safe Drinking Water Act, 1976 PA 399, as amended (Act 399), water system construction permit for the installation of this treatment equipment at Control Station 2 and Pump Station 4, construction permit number W151104, issued on October 28, 2015.

The City should also maintain a minimum pH level of 7.0 throughout the City's water distribution system. If pH levels of 7.0 or less are detected, the City shall immediately notify the MDEQ.

As part of the City water system operations, the City shall conduct:

- **Daily monitoring of incoming DWSD/GLWA water for pH and for orthophosphate residual, as PO_4**
- **Daily monitoring of additional orthophosphate dosage, as PO_4**
- **Daily monitoring of water entering the City distribution system for pH and for orthophosphate residual, as PO_4**

This information shall be included in the City's monthly operation report and shall be reported to the MDEQ as required under Administrative Rule 1502 (R 325.11502) of the administrative rules promulgated pursuant to Act 399.

Enhanced Water Quality Parameter Monitoring

The City's revised monitoring schedule dated October 22, 2015, requires quarterly Water Quality Parameter Monitoring at 25 sites throughout the City's water distribution system for temperature (Celcius), Conductivity (mS), pH, Total Alkalinity (mg/L as $CaCO_3$), Calcium (mg/L as Ca^{2+}), and orthophosphate (mg/L PO_4). Ten of these 25 sites are also used by the City to conduct required total coliform bacteria and chlorine residual monitoring (location numbers 1, 2, 3, 4, 5, 6, 7, 8, CS, and WS). **At these ten locations, the City shall also conduct weekly monitoring for the following parameters at the same time that total coliform bacteria and chlorine residual monitoring is conducted to further assess water stability:**

- **Turbidity (NTU)**
- **Iron (mg/L)**
- **Orthophosphate (mg/L PO_4)**
- **pH**
- **Total Alkalinity (mg/L as $CaCO_3$)**
- **Calcium (mg/L as Ca^{2+})**
- **Chloride (mg/L as Cl^-)**
- **Temperature (Celcius)**
- **Conductivity (mS)**

In addition to the 10 locations, the entry point to the distribution system should be one of the locations for enhanced water quality parameter monitoring.

If orthophosphate residual levels less than 3.1 mg/L as PO_4 (1.0 mg/L as P) are detected at any of these locations, then orthophosphate dosage shall be increased to achieve the minimum phosphate residual of 3.1 mg/L as PO_4 (1.0 mg/L as P) at all locations. In addition, if pH levels of 7.0 or less are detected at any of these locations, the City shall immediately notify the MDEQ.

Corrosion Control Treatment Test Loops

To further confirm the effectiveness of corrosion control treatment and the City's operations, it is recommended that the City construct, install, and monitor test loops of service line and plumbing materials. Instructions for construction, installation, and monitoring of these test loops can be obtained from the United States Environmental Protection Agency's (U.S. EPA) Office of Research and Development. The U.S. EPA has also offered to provide analytical services to support this investigative effort. Please contact Mr. Darren Lytle, Acting Branch Chief, at 512-569-7432 or lytle.darren@epa.gov.

Lead Service Line Verification Sampling

The City has been reviewing customer service connection records in order to confirm customer service line materials at each connection. The U.S. EPA has developed a sampling procedure that can be used to help verify the presence of lead service lines and it is recommended that the City conduct this sampling at a selection of customer locations for this purpose. Information regarding this verification sampling can also be obtained from Mr. Lytle. Any water analysis for samples meeting the criteria for inclusion in the 90^{th} percentile calculation for lead and copper compliance must be completed by a certified laboratory.

Customer Household Exposure Assessment

The Michigan Department of Health and Human Services (MDHHS) is continuing to conduct blood lead level testing for children in the City. Families with children found to have elevated blood lead levels will be asked to have an elevated blood lead level investigation conducted at their residence that will include a lead exposure assessment, including the contribution of lead from water service lines and premise plumbing. This diagnostic testing is different than the first draw sampling being conducted by the City and should help further substantiate the effectiveness of corrosion control treatment. Any water analysis samples meeting the criteria for inclusion in the 90th percentile calculation for compliance purposes for lead and copper must be completed by a certified laboratory.

Flint Water Treatment Plant Evaluation of Karegnondi Water Authority (KWA) Raw Water

The City is planning to change source water in the next year to raw water from Lake Huron purchased from the KWA. The City is required to evaluate the Flint Water Treatment Plant (WTP) processes related to optimization of corrosion control treatment using source water purchased from the KWA to determine if any adjustments are necessary. It is recognized that full scale testing at the Flint WTP may not be feasible. A report of this evaluation shall be provided to our office for review and approval prior to initiating service of this treated water to its customers.

If you have any questions regarding this correspondence, please contact me at the number below or at prysbym@michigan.gov.

Sincerely,

Michael F. Prysby, P.E.
District Engineer
Field Operations Section
Office of Drinking Water and
Municipal Assistance
517-290-8817

cc: Mr. Brent Wright, City of Flint
Mr. Howard Croft, City of Flint
Ms. Natasha Henderson, City of Flint
Mr. Darren Lytle, U.S. EPA
Mr. Samir F. Matta, P.E., Lockwood, Andrews & Newnam, Inc.
Mr. Warren Green, Lockwood, Andrews & Newnam, Inc.
Mr. James Henry, Genesee County Health Department
Dr. Linda Dykema, MDHHS
Mr. Jim Sygo, Chief Deputy Director, MDEQ
Mr. Stephen Busch, MDEQ
Mr. Adam Rosenthal, MDEQ

City of Flint
Final RTCR Coliform Monitoring Plan

September, 2017

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Table of Contents

A. Introduction and Objectives

This Coliform Monitoring Plan (Plan) has been developed for the City of Flint (City) to meet requirements of the Revised Total Coliform Rule (RTCR) and R 325.10704c of Michigan's rules for public water supplies. This August 2017 Plan includes updates in sampling locations, sampling schedule, and contact information as requested by Michigan Department of Environmental Quality (DEQ).

Drinking water systems conduct total coliform monitoring with the objective of evaluating microbial water quality to ensure water provided to consumers is free of disease-causing organisms. While drinking water systems can't evaluate the microbial quality of all water in all locations of their distribution system in a cost-effective manner, a coliform monitoring program allows systems to evaluate water quality in many locations throughout their system on a monthly basis.

This Plan has been developed to meet the following objectives:

- Update the City's coliform monitoring plan to comply with recent requirements of the RTCR.
- Ensure representative routine coliform sampling in the City's system by expanding the number of routine samples collected.
- Provide Standard Operating Procedures (SOPs) for coliform sampling and regulatory reporting.
- Summarize emergency response and public notification procedures in the event of a total coliform or *E. coli* positive sample.
- Provide information for the completion of Level 1 and Level 2 system assessments
- Enhance water quality surveillance.

B. Coliform Monitoring Requirements

The following sub-sections outline coliform monitoring requirements which apply to the City.

According to the 2015 American Community Survey (ACS-2015), the City serves a population estimated to be 98,310. SDWIS records have recently been updated to reflect this population. According to requirements in R 325.10704g, the City is required to collect at least 100 coliform samples throughout their distribution system each month. Samples are analyzed by the City's certified laboratory. The City may, with DEQ approval, decrease sample collection to 90 samples per month if the population drops below 96,000. The City will be required to increase sample collection to 120 per month if the population served by the City increases to more than 130,000.

Coliform samples are analyzed for the presence or absence of total coliform. A satisfactory test indicates no coliform are present. An unsatisfactory test is positive for the presence of coliform bacteria. Further testing is conducted on unsatisfactory samples to determine if *E. coli* is present.

Repeat samples are required if the routine sample is unsatisfactory. Three repeat samples are required at the following locations:

- The same tap as the original unsatisfactory Routine sample.
- An active service within five active connections upstream from where the original unsatisfactory sample was taken*.
- An active service within five active connections downstream from where the original unsatisfactory sample was taken*.

*If sample sites are not available within five connections up or downstream of the routine sample location, alternative sites may be selected that represent the up or downstream water quality.

C. System Information

Flint purchases treated surface water (finished water) from the Great Lakes Water Authority to serve a population of approximately 98,310 (per 2015 census). Finished water enters the system at the water treatment plant and is continuously monitored for free chlorine residual. Chlorine, caustic soda (as needed), and orthophosphate are supplemented at this location (CSII). The water is then distributed to the City's system via one transmission line. The City has four reservoirs for a total of 58 MG of storage capacity. The City is comprised of a single pressure zone, although there is a small pumped pressure district in the southwest region of the City. Approximately 90% of the City's distribution system is comprised of unlined cast iron pipe.

Table 1. System Information

Water System Name:	City of Flint
Address:	4500 North Dort Highway Flint, MI 48505
County:	Genesee
WSSN:	2310
Population Served:	98,310 (2015 census)

D. Key Contacts

As of August 2017, the following are the key contacts from the City, DEQ, County, and local news media for RTCR monitoring and emergency response activities.

Table 2. Key Contact Information

Name	Title	E-mail	Phone number(s)
City of Flint – Water System			
Rob Bincsik	Distribution Supervisor	rbincsik@cityofflint.com	(810) 787-6537
Vacant (duties assigned to F&V, contact is Rob Jones)	Water Plant Supervisor	www.fv-operations.com	(616) 588-2900
Vacant	Lab Supervisor	To be Determined	(810) 787-6537
Michigan DEQ			
Bob London (primary contact for RTCR)	Corrosion Control Specialist	londonr@michigan.gov	(989) 450-7834
Jon Bloemker	KWA Team Leader	bloemkerj@michigan.gov	(989) 460-7254
Brian Thurston	Distribution Specialist	thurstonb@michigan.gov	(231) 590-3430
Pollution Emergency Alerting System			1-800-292-4706
City of Flint			
Dr. Karen Weaver	Mayor	kweaver@cityofflint.com	(810) 766-7346
Sylvester Jones	City Administrator	sjones@cityofflint.com	(810) 237-2057
Kristin Moore	Public Relations Director	kmoore@cityofflint.com	(810) 875-2576
Dr. Pamela Pugh	Chief Public Health Advisor	ppugh@cityofflint.com	(810) 237-2041
Genesee County Health Department			
Jim Henry	Environmental Health Director	jhenry@gchd.us	(810) 257-3612 (517) 404-8401 (cell)
Mark Valacak	Health Officer	mvalacak@gchd.us	(810) 257-3588
Public Notification - Media			
mlive – Flint Journal		flnews@mlive.com	(810) 766-6100
Channel 25 - WEYI			(810) 687-9612

E. Sample Locations and Schedule

Under this revised plan, a minimum of 25 samples will be collected each week from 25 unique locations*. Between January and August 2017, the City collected a minimum of 30 coliform samples each week from 20 unique locations. Prior to 2017, the City collected coliform samples from 10 unique locations. The RTCR requires systems to identify sample sites that are representative of the system. Features that should be represented through coliform monitoring include pressure zones, unique sources, areas served by reservoirs, and vulnerable conditions such as dead ends, transient usage, high water age, high hazard cross connections, and sensitive populations. While the ten historical coliform

sample sites are geographically spread throughout the system, recent water quality concerns and identification of new areas of low chlorine residual have prompted a re-evaluation of the sample sites under the RTCR. The City's 10 existing TCR sites have been retained, and 15 new sites have been selected to capture a variety of conditions to ensure that microbiological water quality is maintained throughout the system. In addition to coliform, the sites are sampled for chlorine residual. These sites were selected with input from Flint staff, EPA, MDEQ and Arcadis staff after consideration for site accessibility, upstream/downstream access, and safety.

The sample sites are presented geographically on the attached RTCR Sample Site Map. Site nos. 21-25 were monitored for chlorine residual only in the first half of 2017. With the exception of Site 25, these locations will be available to the City for surveillance or investigative monitoring as needed. Site 25 was converted to a new RTCR site. Table 3 lists the City's historical (pre-2017) and new routine coliform sampling locations, surveillance monitoring locations, sampling schedule, and repeat sample site locations for coliform sites. Sampling will occur on the days indicated in the third column when possible and adjustments will be made on an as-needed basis for holidays and irregular months.

Table 3. Monthly Total Coliform Monitoring Locations

Dist. Site #	Routine Site Address	Sampled on Which Days	Historical Sampling Site	Planned Upstream Site Address[1]	Planned Downstream Site Address[1]
1	2501 Flushing Rd University Market	Th	TCR[2]	2702 Flushing	1117 N. Chevrolet Ave
2	3 1621 Saginaw Street Ten Fu Chinese Gourmet	M	RTCR[4]	1638 Saginaw St	1709 Saginaw St
3	3609 Beecher Palace Liquor Store	W	EPA Chlorine Monitoring[3]	3617 Beecher Rd	3505 Beecher Rd
4	3521 Corunna Rite-Aid	W	Quarterly (DBP)[5]; former Taco Bell site upstream[2,]	3606 Corunna	3409 Corunna
5	1100 Cedar Cedar St Reservoir	W	TCR[2]	702 12th St	1035 Ann Arbor
6	611 W. Court Street, Ste. 200 Dean T. Yeotis Law Offices	W	RTCR[4]	620 W. Court	521 W. Court
7	1159 Foss Ave. Foss Avenue Church	Tu	EPA Chlorine Monitoring[3]	1185 Foss Ave	1164 E. Holbrook Ave.
8	6204 N. Saginaw St North Flint Automotive	Tu	TCR[2]	6101 N. Saginaw St	6509 N. Saginaw St
9	5018 Clio Rd	Tu	TCR[2]	5005 Cloverlawn Rd	4825 Clio Rd

Dist. Site #	Routine Site Address	Sampled on Which Days	Historical Sampling Site	Planned Upstream Site Address[1]	Planned Downstream Site Address[1]
	Rite-Aid				
10	4090 Clio Road Auto Zone	Tu	RTCR[4]	4117 Clio Rd	4006 Clio Rd
11	1416 Dupont St West Side Reservoir	Th	TCR[2]	1360 Dupont St	1430 Dupont St
12	503 Garland Street Hoffman's Deco Deli & Café	W	RTCR[4]	605 Garland	401 Garland
13	3538 Richfield Rd Grandma Recipes	F	Quarterly (DBP)[5]	3246 Richfield Rd	3702 Richfield Rd
14	3802 Davison Rd Admiral	F	Former Arby's TCR site downstream[2]	3718 Davison Rd	3835 Davison Rd
15	2132 Davison Road Luigi's Restaurant	F	RTCR[4]	2320 Davison Rd	2100 Davison Rd
16	2838 E. Court St Rite-Aid	M	TCR[2]	905 S. Dort Hwy	2845 E. Court St
17	3302 S. Dort Hwy Liquor Palace	M	TCR[2]	3124 S. Dort Hwy	3316 S. Dort Hwy
18	3717 Fenton Rd Rite-Aid	M	Quarterly (DBP)[5]	3708 Fenton Rd	3621 Fenton Rd
19	3216 MLK Blvd Salem Housing	Th	TCR[2]	3110 MLK Ave	3317 MLK Ave
20	1525 MLK Fire House #3	Th	RTCR[4]	1402 MLK	1602 Oren Ave
21	510 Leta Avenue Don's Market CHLORINE ONLY	-	Former Surveillance Chlorine Monitoring[3]	Not applicable	Not applicable
22	1002 W. Home Ave Hasselbring senior center CHLORINE ONLY	-	Former Surveillance Chlorine Monitoring[3]	Not applicable	Not applicable
23	4612 Western Rd Sam's Rollingwood Market CHLORINE ONLY	-	Former Surveillance Chlorine Monitoring[3]	Not applicable	Not applicable
24	3109 Kleinpell St Genesee Community	-	Surveillance Chlorine	Not applicable	Not applicable

Dist. Site #	Routine Site Address	Sampled on Which Days	Historical Sampling Site	Planned Upstream Site Address[1]	Planned Downstream Site Address[1]
	Health		Monitoring[3]		
25	3402 Western Rd Fire House #5	F	New[3,6]	3415 Western Rd	3220 Western Rd
26	4301 Dupont St Pro Clean Cleaners	Tu	New[5,6]	701 Stewart	4311 Dupont St.
27	3311 Saginaw St. Post Office	Th	New[5,6]	3300 Saginaw St.	3009 Saginaw St.
28	Flint Institute of Arts 1120 E Kearsley St	F	New[5,6]	1026 E Kearsley St	1025 E Kearsley St
29	3440 Lapeer Rd. Maxi Quality Meats	M	New[5,6]	3329 Lapeer Rd.	3502 Lapeer Rd.

[1]When a routine sample is positive for total coliform or *E.coli*, collect samples from repeat sites in the distribution system. Supplies that purchase their source water must notify their supplier of water within 24 hours of a positive routine sample result. Surface water supplies are not required to sample their source water.
[2]Sample site was previously used for the Total Coliform Rule monitoring plan.
[3]Sample site was previously used for surveillance chlorine monitoring.
[4]Sample site was a new site used for RTCR monitoring beginning in January 2017.
[5]Sample site is currently used for quarterly expanded water quality parameter (EWQP) and disinfection byproduct monitoring (DBP).
[6]RTCR sample site added in August 2017.

Repeat Sample Sites

Most of the repeat sample sites shown in Table 3 are within five active connections up/downstream of the routine sample site. The City will attempt to use the repeat sample locations shown in Table 3 for repeat coliform sample collection; however, because they are not routine sample locations, there are times when they may be unavailable. In that case, the City will use an alternate site that is representative of the water quality for the routine sample site. If an alternative site is needed, the City will send a written justification to DEQ for use of the alternative site.

F. Sampling and Reporting SOP

Monthly Monitoring

1. Collect samples at regular time intervals throughout the month.
2. Failure to collect all required routine samples in a monitoring period is a violation. Another total coliform monitoring violation in the following 12 months will result in a fine. Notify the DEQ if monitoring was not performed as required.

Sample Instructions

Sample Containers – Sample containers used for microbiological examination are collected in

plastic or glass bottles that have been cleansed, carefully rinsed, and sterilized. For drinking water samples containing chlorine, the sample bottles should contain a dechlorinating agent. The dechlorinating is added prior to sterilization.

Sample Collection Procedure – **Overview:** When collecting a sample leave ample air space in the bottle to allow for mixing before examination. When using Idexx 120mL sample bottles, fill bottle to 100mL line. Flush and disinfect sample port and use aseptic techniques to avoid sample contamination. The sample should be representative of the water being tested. If the sample is taken from a distribution system tap, select a tap that is water from a service pipe directly connected with the water main.

Detailed Instructions:

1) Remove any tap attachments such as aerators or filters.
2) If tap cleanliness is questionable, apply disinfectant (100 mg/L solution of sodium hypochlorite or alcohol wipes) to sample tap before flushing service line.
3) Open tap fully and let water run until the water is cold, to permit turnover of the water in the service line and premise plumbing prior to the sample point.
4) When sampling from a mixing faucet, run hot water for 2 to 3 minutes, then cold water until cold.
5) Flush the tap until you measure a temperature change, then record the chlorine residual level. Measure and record the chlorine residual at the same time and place as every routine and repeat sample collected.
6) Reduce water flow to permit filling of sample bottle without splashing, and to prevent over filling.
7) Remove cap from bottle and hold cap with the inner surface facing downward. Do not set cap down. Dust-like particles in the bottle are a preservative; do not empty out or rinse out this preservative.
8) Fill the bottle to 100 mL line. Avoid contact with sample tap or other surfaces. Do not overfill or underfill.
9) Recap the sample bottle before turning off the water.
10) Complete the laboratory chain of custody form and attach it to the sample bottle.

Procedure When Sample Result Is POSITIVE

1) If a distribution system sample result is positive for total coliform bacteria or *E.coli*, then collect repeat samples **within 24 hours** of learning of the positive result from all of the following sites:
    a. The site of the positive sample result; and
    b. An upstream site within five service connections of the original positive site; and
    c. A downstream site within five service connections of the original positive site; and

Note: If approved by the DEQ, when an upstream repeat site is temporarily not available, sample the

closest available location to the repeat site that is also upstream of the routine site and similarly for the downstream side.

2) Notify the DEQ District Office **within 24 hours** to learn what further action is required when greater than 5.0 percent are positive. Follow up action includes a formalized assessment of the water supply.
3) Notify the DEQ District Office **by the end of the day** if any sample result is positive for *E.coli*.
4) For an *E. coli* MCL Violation, public notification is required within 24 hours. Due to the public health risk, a boil-water advisory will typically be issued in response to an *E. coli* MCL violation. An *E. coli* MCL violation will trigger a Level 2 Assessment, which is to be completed by DEQ.

City of Flint *E. coli* Response Plan

If we have *E. coli* in our distribution system we will immediately:

1. Call Lab Supervisor and MDEQ by end of the day that the City is notified of positive sample.
2. Contact GLWA
   - Review source water data
   - Identify operational changes
3. Contact Genesee County Public Health
4. Collect repeat samples outlined in Section E or alternate locations that are expected to represent pathways of contamination into the distribution system.
   - Collect investigative samples as needed.
5. Inspection of potential pathways and correct as needed:
   - Review SCADA records for pressure irregularities.
   - Reservoir inspection for potential pathways; screens, hatches, locks, etc.
   - Interview staff for operational changes, water main breaks, pressure outages, etc.
   - Review cross connection program and status.
   - Review construction activities.

See Appendix A for MDEQ Level 1 and 2 Assessment Forms

6. Implement health advisory as directed by MDEQ if deemed necessary.
7. Review repeat sample results.
   - Any repeat samples unsatisfactory: Issue health advisory. Work with MDEQ to Conduct Level 2 Assessment
   - Establish criteria for lifting health advisory.

G. Coliform Violations

Under the RTCR, the non-acute MCL violation (when greater than 5% of monthly samples are positive for total coliform) has been removed. Instead, a Level 1 Assessment must be performed. An MCL violation is issued when the *E. coli* MCL is not met. In this case a Level 2 Assessment must be performed.

Information on Assessments is provided in Section H and Appendix A.

E. coli MCL Violations

An *E. coli* MCL violation occurs if a routine sample and at least one related repeat sample both have coliform bacteria present and one of the samples is positive for the presence of *E. coli*. If this occurs, contamination is confirmed in the water supply.

If an *E. coli* MCL violation occurs, follow the steps outlined in Section F.

Other Types of Violations

Other types of violations related to RTCR compliance include treatment technique violations, monitoring violations, and reporting violations:

- **Treatment Technique (TT) violations** result from failure to perform appropriate assessments or correction actions. TT violations require Tier 2 public notification (public notice as soon as practicable, but not later than 30 days following the violation).
- **Monitoring violations** result from a failure to collect any coliform sample (routine or repeat) or a failure to analyze an unsatisfactory total coliform positive sample for *E. coli* bacteria. Tier 3 public notification is required for monitoring violations. For this type of notification, the City must communicate the violation to customers within 12 months of the violation, which could be included in the Consumer Confidence Report (if it is issued within 12 months).
- **Reporting violations** result from failure to submit a monitoring report or completed assessment form in a timely manner or failure to notify MDEQ following an *E. coli* positive sample in a timely manner. Reporting violations require Tier 3 public notification.

H. Assessments

A key component of the RTCR is to require a system assessment when triggered by results from coliform monitoring. The two types of assessments are described below.

Level 1 Assessment

A Level 1 Assessment is triggered when more than 5% of monthly samples are TC+ or when the system fails to collect any required repeat samples following a TC+. The assessment is an evaluation intended to identify possible presence of sanitary defects, defects in DS coliform monitoring practices, and (when possible) the likely reason that the supply triggered the assessment. The Level 1 Assessment is conducted by the system's owner and/or operator. Information gathered in the assessment is described on the *MDEQ Level 1 Assessment Form for Community Water Supplies* (included in Appendix A) and submitted to MDEQ for review within 30 days of learning that the assessment was triggered. The form must identify any sanitary defects found during the investigation and provide a list of corrective actions that were completed during the investigation and/or a proposed time table for completing corrective actions.

Level 2 Assessment

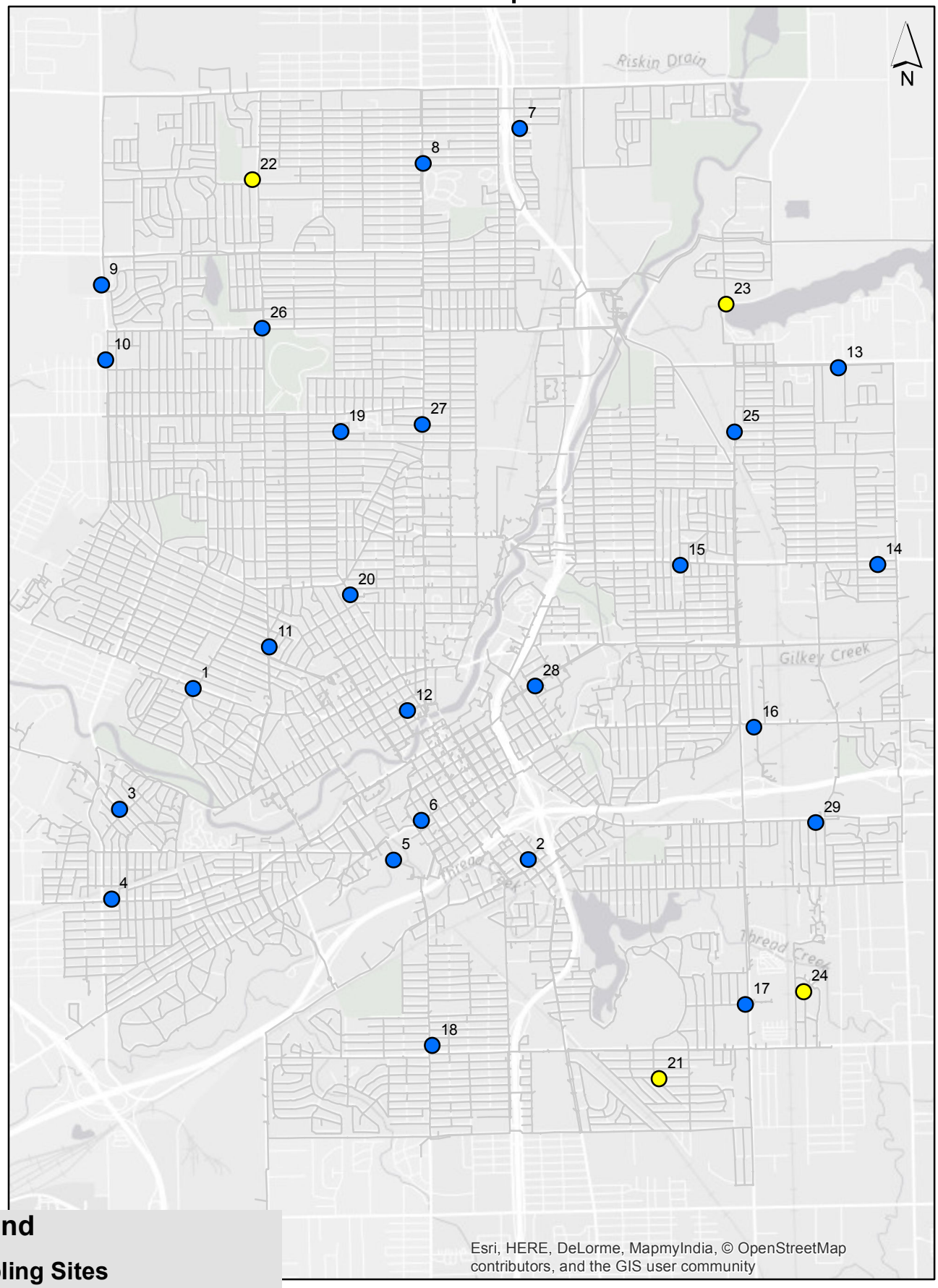
A Level 2 Assessment is triggered by an *E. Coli* MCL violation or when two Level 1 Assessments are triggered within a rolling 12-month period. A Level 2 Assessment is a more detailed evaluation than a Level 1 Assessment and is conducted by the State. MDEQ will send a team of staff members to Flint to complete the assessment. The team will conduct the assessment as soon as practicable and generally within one week of being notified of the violation. An example Level 2 Assessment Form is provided in Appendix A.

Table 4 provides a basic comparison of Level 1 and Level 2 Assessments.

Table 4. Comparison of Level 1 and Level 2 Assessment Requirements

	Level 1 Assessment	Level 2 Assessment
Trigger for assessment	● TC+ in >5% of monthly samples, or ● Failure to collect any repeat samples following TC+ sample	● *E. Coli* MCL violation, or ● Two Level 1 Assessments required within 12-month period
Party responsible for completing assessment	Supply owner or operator	MDEQ
Assessment Deadline	● City to initiate assessment as soon as practicable after learning of trigger ● Submit assessment form to DEQ **within 30 days** of learning that a trigger was exceeded	● MDEQ to initiate assessment as soon as practicable after learning of trigger ● Correct sanitary defects as soon as practicable or on State-approved timeline identified in form
Assessment Form	Level 1 assessment form for community water supplies (Appendix A)	Level 2 assessment form for community water supplies (Appendix A)
Minimum assessment elements	● Review and identification of atypical events that could have affected or impaired distributed water quality ● Changes in DS O&M that could affect DS water quality (inc. storage) ● Source and treatment considerations affecting DS water quality ● Review of water quality data ● Inadequacies in sample sites, sampling protocols, and sample processing ● Form describing sanitary defects detected, corrective actions completed, and a proposed timetable for each corrective action not already completed	

City of Flint
RTCR Sample Sites



Legend

Sampling Sites

- RTCR Sampling Sites
- Other Available Sampling Sites

September, 2017

0 0.325 0.65 1.3 1.95 2.6
Miles

Appendix A - Level 1 and 2 Assessment Forms

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF DRINKING WATER AND MUNICIPAL ASSISTANCE

LEVEL 1 ASSESSMENT FORM FOR COMMUNITY WATER SUPPLIES

Issued under authority of the Safe Drinking Water Act, 1976 PA 399, as amended, MCL 325.1001 et seq., and its Administrative Rules (Act 399).

This form must be completed and submitted to the appropriate DEQ District Office as soon as possible, but no later than 30 days after the supply triggered the assessment. It should be completed by the Operator In Charge, Water Supply Owner, or a knowledgeable representative of the water system.

1. General Information

CWS Name:	WSSN:
Assessor Name:	Assessor Title:
Phone Number:	E-mail:
Trigger Event: Greater Than 5% Total Coliform Positives ☐ ***or*** Failure to Collect All Repeat Samples ☐	
Date Assessment Triggered:	Date Assessment Completed:

2. Bacteriological Sample Summary (Include all results associated with monitoring period, add additional pages if necessary)

Date & Time	Location	Purpose (Routine, Repeat, Triggered, Construction, Repair)	Result (ND, TC+, EC+, invalid, interference)	Collected By	Laboratory

3. Assessment Questions: Answer each question in Subsections A - G either Yes, No or Not Applicable (NA). Review and evaluate each question for potential causes of contamination. If the answer to any of these questions is unknown, leave blank and indicate on a separate sheet what actions will be taken to determine the necessary information.

A. Sample Site Selection and Sample Collection	**Answer**		
	Yes	**No**	**NA**
Were the samples collected in accordance with the Sample Site Plan?	☐	☐	☐
Was the location and condition of the sample tap sanitary?	☐	☐	☐
Were proper sample collection procedures followed?	☐	☐	☐
Were the samples submitted to the lab in a timely & acceptable manner?	☐	☐	☐

B. Source – Wells (if wells are not used check here ☐ and go to subsection C)	**Answer**		
	Yes	**No**	**NA**
Do the wells have a proper well cap, sanitary seal and vent screens?	☐	☐	☐
Have the wells/pumps undergone any recent repairs or maintenance activities?	☐	☐	☐
Is the exposed portion of the casing (including electrical conduit) in good condition?	☐	☐	☐
Is the area near the well cap/casing free of insects, bugs, brush and vegetation?	☐	☐	☐
Is there standing water or other unsanitary conditions near the wells?	☐	☐	☐
Any signs of vandalism to wells or forced entry into well houses?	☐	☐	☐

C. Source – Surface Water (if surface water is not used check here ☐ and go to subsection D)	Answer		
	Yes	No	NA
Are there any new potential contamination sources, or visible signs of unsanitary conditions near the raw water intake?	☐	☐	☐
Any signs of vandalism or unauthorized access to source facilities?	☐	☐	☐
Was there any heavy precipitation, rapid snowmelt or flooding recently?	☐	☐	☐
Any unusual changes to quality of the raw water like a spike in turbidity, sudden change in pH or very high heterotrophic plate counts?	☐	☐	☐

D. Treatment (if no treatment check here ☐ and go to subsection E)	Answer		
	Yes	No	NA
Have there been additions or modifications to any treatment process?	☐	☐	☐
Have there been interruptions in any treatment process?	☐	☐	☐
Any signs of vandalism or unauthorized access to treatment equipment or facilities?	☐	☐	☐
Are there any issues with operation or maintenance of treatment equipment, units or processes?	☐	☐	☐
Is there any water quality data that indicates treatment is ineffective?	☐	☐	☐

E. Storage (if no water storage tank check here ☐ and go to subsection F)	Answer		
	Yes	No	NA
Are there any holes, leaks or other structural problems?	☐	☐	☐
Are access hatches and manhole openings tightly covered and secured?	☐	☐	☐
Are all vents and overflow pipes screened?	☐	☐	☐
For hydropneumatic tanks, is the tank waterlogged?	☐	☐	☐
Any signs of vandalism or unauthorized access to storage facilities?	☐	☐	☐
Have the tank(s) been recently drained, cleaned or inspected?	☐	☐	☐

F. Distribution System	Answer		
	Yes	No	NA
Have there been any low pressure events (≤ 20 psi)?	☐	☐	☐
Have there been any water main breaks, repairs, or new main installations?	☐	☐	☐
Have there been any recent fires or hydrant flushing?	☐	☐	☐
Have there been any booster pump issues, repairs or new installations?	☐	☐	☐
Is the supply actively performing cross connection control inspections, including frequent testing of all testable backflow preventers?	☐	☐	☐
Have there been other construction activities like hydrant or valve replacement that could have introduced contamination into the system?	☐	☐	☐
If samples were collected from inside a building, has there been any recent plumbing work performed within the building?	☐	☐	☐

G. Operation and Maintenance (O & M)	Answer		
	Yes	No	NA
Any changes in procedures or staff effecting O & M activities?	☐	☐	☐
Any water quality data collected from the treated water tap or distribution system show results are indicative of an issue?	☐	☐	☐
Any complaints from customers related to water quality or low pressure?	☐	☐	☐
Any other issues or items that may have caused bacteriological contamination?	☐	☐	☐

4. Issue Description: For any answer in Part 2, Subsections A - G that are in a shaded box, use this space to describe the event and provide additional information on potential causes of contamination identified during the assessment. Include corresponding dates with your findings. Attach additional page(s) if needed. Include date(s) of low pressure events, water main breaks, maintenance activities, etc. with your findings.

5. Corrective Actions Taken or to be Taken for any Issues Identified in Part 3: Use this space to describe corrective actions already taken and date(s) completed; or a proposed timetable for corrective actions not yet completed. Attach additional page(s) if needed.

6. Certification: I hereby certify that the information contained herein is true, accurate and complete to the best of my knowledge and information.	
Assessor's Name (printed):	
Assessor's Signature:	**Date:**

DEQ USE ONLY: This section is to be completed by DEQ.	
Reviewer Name:	**Date Reviewed:**
Date Received:	**Within 30 days of trigger: Yes ☐ No ☐**
Assessment Complete: Yes ☐ No ☐	**Likely Reason for Positive Samples Identified: Yes ☐ No ☐**
Corrective Actions Completed: Yes ☐ No ☐ NA ☐	**Proposed Schedule Acceptable: Yes ☐ No ☐ NA ☐**
Assessment Level Reset Yes ☐ No ☐	
Comments:	

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
OFFICE OF DRINKING WATER AND MUNICIPAL ASSISTANCE

LEVEL 2 ASSESSMENT FORM FOR COMMUNITY WATER SUPPLIES

Issued under authority of the Safe Drinking Water Act, 1976 PA 399, as amended, MCL 325.1001 et seq., and its Administrative Rules (Act 399).

This form must be completed as soon as possible, but no later than 30 days after the supply triggered the assessment. It must be completed by DEQ - Office of Drinking Water & Municipal Assistance staff.

1. General Information	
CWS Name:	WSSN:
DEQ Staff Completing Assessment:	
Name & Title of Person Representing the CWS During Assessment:	
Level 2 Trigger: *E. coli* MCL ☐ ***or*** 2nd Level 1 Assessment in 12 months ☐	
Date Assessment Triggered:	Date Assessment Completed:

2. Bacteriological Sample Summary (Include all results associated with monitoring period, add additional pages if necessary)

Date & Time	Location	Purpose (Routine, Repeat, Triggered, Construction, Repair)	Result (ND, TC+, EC+, invalid, interference)	Collected By	Laboratory

3. Assessment Questions: Answer each question in Subsections A - H either Yes, No or Not Applicable (NA). Review and evaluate each question for potential causes of contamination. If the answer to any of these questions is unknown, leave blank and indicate on a separate sheet what actions will be taken to determine the necessary information, including any supplemental information that needs to be provided by the water supply.

A. Sample Site Selection and Sample Collection	**Answer**		
	Yes	**No**	**NA**
Were the samples collected in accordance with the Sample Site Plan?	☐	☐	☐
For positive samples, were the taps used in appropriate condition for collection?	☐	☐	☐
For positive samples, were the taps used on a regular basis?	☐	☐	☐
Did someone other than a regular sample collector collect the samples?	☐	☐	☐
Were proper sample collection procedures followed? (tap flushed, aerator removed, cap properly handled, clean and sealed sample bottles used, bottles not rinsed, etc.)	☐	☐	☐
Were the samples kept cool and delivered to the lab within 30 hours of collection?	☐	☐	☐
Have there been any recent plumbing changes or construction at the site?	☐	☐	☐
Any identified cross connections near the sample tap or premise plumbing?	☐	☐	☐
Is there any Point of Entry (POE) treatment units after the service line connection or in the premise?	☐	☐	☐
Is there any Point of Use (POU) treatment units at the sample tap(s) location?	☐	☐	☐

B. Source – Wells (if wells are not used check here ☐ and go to subsection C)	**Answer**		
	Yes	**No**	**NA**
Do the wells have approved and secured well caps or sanitary seals?	☐	☐	☐
Are the well caps or sanitary seals vented and screened?	☐	☐	☐
Is the top of the well head at least 12-inches above grade?	☐	☐	☐

B. Source – Wells (if wells are not used check here ☐ and go to subsection C)	Answer		
Is the electrical conduit damaged or not sealed to the well cap?	☐	☐	☐
Is the ground graded to prevent water flow towards the wells?	☐	☐	☐
Is there standing water or other unsanitary conditions near the wells?	☐	☐	☐
Have any wells/pumps undergone any recent repairs or maintenance activities?	☐	☐	☐
Do the wells have adequate isolation distances from sources of contamination?	☐	☐	☐
Does the raw water quality data indicate changes to the source water quality?	☐	☐	☐
Has the pumping capacity of the well(s) changed recently?	☐	☐	☐
Have there been any sewer or chemicals spills, or other disturbances near the wells?	☐	☐	☐
Have any backup or emergency wells been placed into service?	☐	☐	☐

C. Source – Surface Water (if surface water is not used check here ☐ and go to subsection D)	Answer		
	Yes	No	NA
Is the intake screened and in good condition?	☐	☐	☐
Any signs of vandalism or unauthorized access to source facilities?	☐	☐	☐
Does the raw water quality data indicate changes to the source water?	☐	☐	☐
Are there any obvious sources of contamination in the source?	☐	☐	☐
Have there been any sewer or chemicals spills, or other disturbances in the area of the source?	☐	☐	☐
Any signs of Algal blooms?	☐	☐	☐
Was there any heavy precipitation, rapid snowmelt or flooding recently?	☐	☐	☐
Any signs of drought or low water levels in the source?	☐	☐	☐
Has source water turnover occurred?	☐	☐	☐

D. Well House or other Low or High Service Pump House (if there are no well/pump houses, check here ☐ and go to subsection E)	Answer		
	Yes	No	NA
Are there unsanitary conditions?	☐	☐	☐
Any openings where animals may enter?	☐	☐	☐
Are there signs of animal activity?	☐	☐	☐
Are air/vacuum relief valves properly screened and air gapped?	☐	☐	☐
Are any vents/reliefs associated with control valves air gapped and not subject to flooding?	☐	☐	☐
Any cross-connections (piping in drains, chemical feed, irrigation, fire suppression)?	☐	☐	☐
Is the pump-to-waste piping capped and air gapped?	☐	☐	☐
Is the well/pump house subject to flooding?	☐	☐	☐
Is the well/pump house used for any other purposes such as storage or maintenance activities?	☐	☐	☐
Is there evidence of unauthorized entry?	☐	☐	☐

E. Treatment (if no treatment check here ☐ and go to subsection F)	Answer		
	Yes	No	NA
Have there been additions or modifications to any treatment process?	☐	☐	☐
Have there been interruptions in any chemical feed, treatment unit or process?	☐	☐	☐
Have there been any recent maintenance or repair of treatment equipment?	☐	☐	☐
Are all treatment devices and processes operational and properly maintained?	☐	☐	☐
Any signs of vandalism or unauthorized access to treatment equipment or facilities?	☐	☐	☐
Are there any signs that the chemicals being fed have been contaminated (discoloration, unusual odors, suspended particles, etc.)?	☐	☐	☐
If chlorine is used, was there a detectable residual at the sample sites where the positive samples occurred?	☐	☐	☐
If chlorine is used, is a residual currently being detected at the plant tap and within the distribution system?	☐	☐	☐
Were there any instances where C*T was not properly maintained?	☐	☐	☐
Does water quality data indicate inadequate or inappropriate treatment of water?	☐	☐	☐

E. Treatment (if no treatment check here ☐ and go to subsection F)	Answer		
	Yes	No	NA
If sand/gravel or other mixed media filtration is used, are the media depths near the original design depths and are the underdrains in good condition?	☐	☐	☐
Did the plant flow exceed the state rated treatment capacity?	☐	☐	☐
For surface water plants, did a review of the turbidity data reveal any anomalies?	☐	☐	☐
For membrane plants, is daily integrity testing being performed every 24 hours of operation and do the results indicate that the membranes are in good condition?	☐	☐	☐

F. Storage (if no water storage tank check here ☐ and go to subsection G)	Answer		
	Yes	No	NA
Are there any holes, leaks, cracks or other structural problems that could be a source of contamination?	☐	☐	☐
Are access hatches and manhole openings tightly covered, and secured?	☐	☐	☐
Do the access hatches/openings have a tightly fitted, rim overlapped cover and non-deteriorated gasket?	☐	☐	☐
Are all vents and overflow pipes properly screened?	☐	☐	☐
Are the vents turned downward with an adequate air gap at the termination point?	☐	☐	☐
Do the overflow pipes have at least a 12-inch air gap at the outlet?	☐	☐	☐
Do overflow pipes and downspouts drain water away from the structure?	☐	☐	☐
For hydropneumatic storage, is the tank maintaining adequate minimum pressure?	☐	☐	☐
For hydropneumatic storage, is the tank waterlogged?	☐	☐	☐
Are the storage facilities secured to prevent unauthorized access?	☐	☐	☐
Any signs of vandalism or unauthorized access visible?	☐	☐	☐
Is there evidence of bird activity on the storage tank roof (nests, droppings, feathers, etc.)?	☐	☐	☐
Is any portion of the storage facilities buried or installed below grade?	☐	☐	☐
Has there been any tank maintenance or recent work?	☐	☐	☐
Any recent inspections indicating sanitary deficiencies or recommended repairs?	☐	☐	☐
If the tank has been inspected or removed from service recently, was it properly disinfected and sampled?	☐	☐	☐
If chlorine is used, is there a detectable residual in or leaving the tank(s)?	☐	☐	☐

G. Distribution System	Answer		
	Yes	No	NA
Is there any evidence the system experienced low (< 20 psi) or negative pressure?	☐	☐	☐
Have there been any water main breaks, repairs, or new main installations?	☐	☐	☐
Have there been any firefighting, system flushing or other high demand events recently?	☐	☐	☐
Have there been any distribution system booster pump issues, repairs or new installations?	☐	☐	☐
Have there been other construction activities like hydrant or valve replacement that could have introduced contamination into the system?	☐	☐	☐
Are there hydrants or blow-offs with unplugged weep/drain holes located in areas of high water table or poorly draining soils?	☐	☐	☐
Are there any dead-ends that are not flushed on a regular basis?	☐	☐	☐
Are there any air relief valves located in vaults where the vent terminates below grade or are not properly air gapped above grade?	☐	☐	☐
Is the supply actively performing cross connection control inspections, including regular testing of all testable backflow preventers including those at residential accounts?	☐	☐	☐
Is there any evidence of intentional contamination in the distribution system?	☐	☐	☐
Are there any control or altitude valves subject to flooding?	☐	☐	☐

H. Operation and Maintenance (O & M)	Answer		
	Yes	No	NA
Any changes in procedures or staff effecting O & M activities?	☐	☐	☐
Is maintenance of all facilities and equipment being performed per appropriate schedule?	☐	☐	☐
Any recent interruptions to electrical power?	☐	☐	☐
Have there been any automation/control system interruptions recently?	☐	☐	☐

H. Operation and Maintenance (O & M)	Answer		
	Yes	No	NA
Any complaints from customers related to water quality or low pressure?	☐	☐	☐
Have there been any illnesses reported or suspected of being waterborne?	☐	☐	☐
Any other issues that could have contributed to bacteriological contamination?	☐	☐	☐

4. Issue Description: For any answer in Part 3 that is in a shaded box, use this space to describe the event and provide additional information on potential causes of contamination identified during the assessment. Include corresponding dates with your findings. Attach additional pages if needed. Include dates of sample collection, water main breaks, maintenance activities, etc. with your findings.

5. Corrective Actions Taken or to be Taken for any Issues Identified in Part 3: Use this space to describe corrective actions already taken and date completed; and/or a proposed timetable for corrective actions not yet completed. Attach additional pages if needed.

6. Certification: I hereby certify that the information contained herein is true, accurate and complete to the best of my knowledge and information. Must be DEQ - ODWMA staff.

Assessor's Name (printed):	
Assessor's Signature:	**Date:**

---

7. DEQ District Supervisor Review: This section is to be completed by DEQ District Supervisor.

Supervisors Name:	**Date Reviewed:**
Date Received:	**Within 30 days of trigger:** Yes ☐ No ☐
Assessment Complete: Yes ☐ No ☐	**Likely Reason for Positive Samples Identified:** Yes ☐ No ☐
Corrective Actions Completed: Yes ☐ No ☐ NA ☐	**Proposed Schedule Acceptable:** Yes ☐ No ☐ NA ☐
Assessment Level Reset: Yes ☐ No ☐	
Comments:	

SODIUM HYPOCHLORITE ADDITION SOP

SOP#: SOP.XXX

Rev: 1.0

Rev Date: MM/DD/YYY

SOP VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Approved by

Staff Acknowledgement

I certify that the requirements of this SOP have been communicated to me and that I am trained in its use. A copy of this page will be distributed to the employee training record file.

Name	Date
_____	_____
_____	_____
_____	_____
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_____	_____
_____	_____

APPROVAL SIGNATURES

Prepared by: _____ Date: _____

Approved by: _____ Date: _____

1 DEFINITIONS AND ACRONYMS

CS-2	Control Station 2
GLWA	Great Lakes Water Authority
gph	gallons per hour
lb/gal	pounds per gallon
MGD	million gallons per day
mg/L	milligrams per liter
mL	milliliter
mL/min	milliliters per minute
mL/hr	milliliters per hour
PPE	personal protective equipment

2 KEY PERSONNEL AND RESPONSIBILITIES

- Operator Maintainer:
  - Complete daily check of chlorine dose and pumping equipment, including all pump, tote, and hose fittings for drips and leaks.
  - Adjust feed rate to achieve target chlorine residual concentration.

3 SCOPE/PURPOSE

Increase the free chlorine concentration of the incoming influent water to the target concentration (95% greater than 0.5 mg/L in the distribution system) by adjusting the sodium hypochlorite feed system flowrate.

4 HEALTH AND SAFETY

The following PPE is required while inside the chlorine feed room:

- Chemical resistant gloves
- Face shield
- Chemical resistant apron

Additionally, the facility is equipped with an emergency eyewash station

5 PROCEDURE

Equipment Required:

- One 220 gallon tote of 12.2 percent sodium hypochlorite with containment
- Two 4 gph LMI feed pumps (one in service, one on standby)
- One 1000 mL calibration column
- Two digital timers (one is needed for the procedure, plus one spare)
- Daily record sheet

Procedure:

1. Prior to traveling to CS-2, read the free chlorine residual (mg/L) from the CL17 analyzer in the water treatment plant basement. Record the free chlorine residual on the daily sheet. The residual should be 1.5 mg/L +/- 10%. (Note that the target free chlorine residual leaving CS-2 will vary seasonally to achieve a minimum residual of 0.5 mg/L in 95% of all distribution system samples.)
2. Read influent supply flow from control panel in CS-2. Record the flow on the daily sheet.
3. Calculate the dosage needed to reach the target residual:
    a. (dosage needed) = (target residual) – (residual at basement analyzer)
4. If a change in dosage is needed, calculate the new settings using the CHEAT SHEET and adjust the feed pumps accordingly
5. Check stroke and speed on feed pump. Record stroke and speed on the daily sheet.
6. Determine feed rate in milliliters per minute (mL/min)
    a. Open the fill valve on the calibration column, fill calibration column to slightly above the 1000 mL mark and close the fill valve.
    b. Close the valve on the supply line from the tote and reopen the valve to the calibration column.
    c. Watch the level drop in the calibration column. When it reaches the 1000 mL mark, start the timer.
    d. After one minute, close the valve to the calibration column and open the valve to the tote. Read the liquid level (mL) in the calibration column. Subtract the liquid level reading from 1000. The difference is the feed rate in mL/min.
    e. Record the feed rate on the daily sheet.
7. Determine the feed concentration in mg/L (parts per million, ppm)
    a. Multiply the influent supply flow rate (MGD) by 8.34 to get your million pounds of water being treated. Divide this result by 24 to get million pounds of water treated in one hour.
    b. Take the ml/min calculated above, multiply by 60 to get mL/hour, then divide by 3785 to convert to gallons of phosphate fed per hour. Multiply by the weight of bleach (10.15 lb/gal), and multiply by the percent strength of the chlorine solution (for example, for 12.2% strength, multiply by 0.122). This gives you the pounds of pure chlorine fed per hour.
    c. Divide the pounds of pure chlorine by the million pounds of water, and this gives you the feed rate for the hour in mg/l.
8. Adjust pump feed rate as needed. If the free chlorine concentration at the residual analyzer in the water treatment plant basement is outside of the target residual concentration, adjust the pump feed rate and repeat steps 3 through 7.

6 DATA RECORDING AND MANAGEMENT

Following the procedure, enter the following items into the chlorine tracking tool:

- Initial and final chlorine pump feed rate in mL/min and lb/hr
- Influent flow rate (MGD)
- Initial and final free chlorine concentration

7 REFERENCES

None.

EMERGENCY REPAIR OF WATER MAINS SOP

SOP#: SOP.XXX

Rev: 0.0

Rev Date: MM/DD/YYY

SOP VERSION CONTROL

Revision No	Revision Date	Page No(s)	Description	Approved by

Staff Acknowledgement

I certify that the requirements of this SOP have been communicated to me and that I am trained in its use. A copy of this page will be distributed to the employee training record file.

Name	Date

APPROVAL SIGNATURES

Prepared by: _____ Date: _____

Approved by: _____ Date: _____

1 DEFINITIONS AND ACRONYMS

AWWA	American Water Works Association
EAM	enterprise asset management
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
mg/L	milligram per liter

2 KEY PERSONNEL AND RESPONSIBILITIES

- Water Distribution Foreman
  - Oversee main repair and disinfection
  - Determine and implement any follow-up activities
  - Document the break, including the type, repair conditions and activities, process used for disinfection and all sampling results, in the enterprise asset management (EAM) system
- Water Distribution Operators (2 - 4)
  - Conduct repairs and field disinfection process
  - Collect and analyze samples for disinfectant residual and document results
  - Collect bacteriological samples and deliver to the water quality laboratory for analysis
- Laboratory Technician
  - Analyze bacteriological samples and report results to Water Distribution Foreman

3 SCOPE/PURPOSE

The purpose of this SOP is to outline the procedures for repairing a main break, including any necessary flushing, disinfection and water quality testing to be conducted before a main is placed back into service. The procedures presented herein are based on the *Water Research Foundation Report #4307 – Effective Microbial Control Strategies for Main Breaks and Depressurization* (2014) and should be used in conjunction with AWWA Standard C651 – Disinfecting Water Mains. As not all breaks can be repaired in the same manner, crews should use their best judgment when implementing the procedures below.

4 HEALTH AND SAFETY

Main repair often involves several types of hazards, including:

- Traffic Hazards: The field service team should use trucks, temporary signs, and traffic cones, barricades and flashers to prevent automotive accidents and injury to staff. In

addition, a flag crew may be needed to direct traffic in some locations. Trucks should be parked between oncoming traffic and the work area when possible to provide a barrier.

- Heavy Construction / Mechanized Equipment Hazards: Heavy or mechanized equipment may be needed for excavation, trenching, grading, etc. Staff operating the equipment must have the proper training and licensure. Ensure proper distances from the equipment are maintained. Use hand signals / radios to communicate with the operator and spotters as needed when moving equipment. Make eye contact with the operator before coming in the vicinity of the equipment.
- Trenching and Confined Space Entry: If trench work is required, consult the relevant excavation procedures for benching, sloping and shoring depending on depth and conduct work in accordance with the Occupational Safety and Health Administration (OSHA) standards for trenching and excavation. Where applicable, staff working in the trench must have the proper confined space entry training and certification.
- Hazardous Chemicals: Disinfection procedures involve the use of chlorine, which can present various hazardous to staff and the public. Staff should be trained in the use of the specific chemicals to be used and how to address any emergencies that may arise. In addition, staff should follow all precautions when working with chlorine solutions.

Crews should be able to recognize and respond to the potential hazards, and must have the proper training, including knowledge of proper sanitary procedures during repair, and certifications to the complete the applicable tasks. In addition, proper PPE should be worn at all times and will vary depending on the specific repair activity. PPE may include:

- Hard hat
- High visibility safety vest
- Safety glasses
- Work gloves and/or chemical resistant gloves
- Face Shield
- Chemical resistance apron
- Steel-toed boots
- Knee pads (as needed)

5 PROCEDURE

Equipment Required:

- Traffic cones, barricades, and flashers
- Temporary signs/arrow board (warning lights, strobe lights, arrow boards, traffic maintenance signs)
- Water system maps
- Field tools for isolating and repairing the pipe section (e.g., pry bar, valve key or valve box keys for all saws, pipe wrenches, buckets, shovels, welding equipment, pick axes, ladders, flashlights, pipe clamps, couplings, etc.)
- One percent chlorine solution in spray bottles
- One of the following NSF/ANSI 60 certified disinfection chemicals:

    - Chlorine gas
    - Sodium hypochlorite solution
    - Calcium hypochlorite tablets
- NSF/ANSI 60 certified dechlorination chemical, if needed
- Sterile sample bottles treated with sodium thiosulfate, transport cooler, ice packs
- Field chlorine test kit
- Night lights
- Portable dewatering pumps and accessories
- Surface runoff diversionary equipment (sandbags, trench covers, etc.)
- Backfill material or bedding (sand, crushed stone, etc.)

Procedure:

An overview of the procedure based on break type is summarized in Table 1. As not all breaks will fall into these categories and as site conditions (i.e., ability to locate and operate appropriate valves and hydrants) impact the ability to implement the procedures below, crews should use their best judgment when modifying the procedures below and ensure practices comply with AWWA Standard C651. Additional details are provided below.

Table 1: Categories of Main Break Types and Repair Response Procedures (Adapted from Kirmeyer et al., 2014 and AWWA Standard C651-15)

Main Break Type	Type 1	Type 2	Type 3	Type 4
Description				
Description	Controlled pipe repair without depressurization	Controlled pipe repair with depressurization after shutdown	Uncontrolled pipe break with possible water contamination or loss of sanitary conditions during repair	Uncontrolled pipe break with a likelihood of water contamination or loss of sanitary conditions during repair
Pressure Conditions	Positive pressure maintained during break and repair	Pressure maintained during break and excavation, followed by controlled shutdown for repair	Loss of pressure at break site / possible local depressurization (less than 20 psi) adjacent to the break (e.g., severe erosion require pressure to be reduced prior to exposing the pipe)	Loss of pressure at break site / widespread depressurization (less than 20 psi) in the system (e.g., pipe blowout and loss of pressure prior to shutdown)
Risk of Microbiological Contamination	No signs of contaminant intrusion	No signs of contaminant intrusion	Possible contaminant intrusion	Possible / actual contaminant intrusion

Main Break Type	Type 1	Type 2	Type 3	Type 4
Procedures				
Assess Break	Excavate to at least 1' below the pipe invert No shutdown needed; maintain pit water level below break	Excavate to at least 1' below the pipe invert Perform controlled shutdown after pipe is exposed and secured from trench soil/water contamination and maintain pit water level below break	Uncontrolled shutdown Document possible contamination Shut-off customer services in affected area	Immediate or uncontrolled shutdown Document likely contamination Shut-off customer services in affected area
Repair	Repair pipe under positive pressure Disinfect repair parts Swab accessible components with 1% chlorine solution	Repair pipe following controlled shutdown Disinfect repair parts Swab accessible components with 1% chlorine solution	Repair pipe following partial of uncontrolled shutdown Disinfect repair parts Swab accessible components with 1% chlorine solution	Repair pipe following uncontrolled or immediate shutdown Disinfect repair parts Swab accessible components with 1% chlorine solution
Disinfection	Not required	Not required	Conduct slug chlorination (CT of 100 mg/L-min)[1]	Conduct slug chlorination (CT of 100 mg/L-min)[1]
Flushing	Conduct scour flush at 3 fps for a minimum of 3 pipe volumes and confirm water is visually clear Dechlorinate if needed	Conduct scour flush at 3 fps for a minimum of 3 pipe volumes and confirm water is visually clear Dechlorinate if needed	Conduct scour flush at 3 fps for a minimum of 3 pipe volumes and confirm water is visually clear Dechlorinate if needed	Conduct scour flush at 3 fps for a minimum of 3 pipe volumes and confirm water is visually clear Dechlorinate if needed
Disinfectant Residual Sampling	Check free chlorine level at break site; continue flushing until residual levels have returned to typical levels[3]	Check free chlorine level at break site; continue flushing until residual levels have returned to typical levels[3]	Check free chlorine level at break site; continue flushing until residual levels have returned to typical levels[3]	Check free chlorine level at break site; continue flushing until residual levels have returned to typical levels[3]

Main Break Type	Type 1	Type 2	Type 3	Type 4
Public Notification	No boil water advisory needed	No boil water advisory needed	Instruct customers to flush premise plumbing upon return to service Determine if boil water advisory is needed based on depressurization extent and presence of contamination[2]	Instruct customers to flush premise plumbing upon return to service Issue boil water advisory or "Do" Not Drink" Order
Bacteriological Sampling	No sampling needed	If a full pipe section is required during the repair, collect one set of samples; however, the pipeline may be returned to service prior to obtaining the results	Collect bacteriological samples; main may be returned to service prior to completion of the testing depending on the depressurization extent and presence of contamination[2]	Collect bacteriological samples; await confirmation of sample results before placing line back into service

1. In highly tuberculated pipes, a higher CT should be considered to compensate for possible lower flushing efficiency. If exposure of customers to high levels of chlorine cannot be controlled, a minimum free chlorine level of 4 mg/L must be maintained for at least 16 hours in conjunction with flushing, coliform sampling and public notification.
2. If depressurization is limited to the pipe section, or area flushed or disinfected, then a boil water advisory is not needed and main can be returned to service prior to receiving the bacteriological sample results. However, if the area of depressurization is larger than the treated area, then a precautionary boil water advisory should be considered and/or the main should not be released for service until the sample result is confirmed to be absent of coliforms.
3. Residual levels should be at least 90% of ambient or pre-break levels and not more than 4.0 mg/L as required by State and Federal regulations.

1. Upon arrival at the site, evaluate the site for safety (including the appropriate PPE) and set up the appropriate traffic control measures. This may include: warning lights, strobe lights, arrow boards, traffic maintenance signs, cones, flagmen (if necessary), safety vests and/or other PPE. Locate and mark buried utility lines and valves in the vicinity. Check for potential contamination sources, such as septic systems, underground storage tanks, service connections without proper backflow prevention devices, and presence of multistory buildings.

2. If necessary, isolate the pipe section by slowly adjusting valve settings, maintaining positive pressure to reduce backflow or runoff contamination. Where possible, service

disruptions should be minimized; however, it may be necessary to isolate certain areas to minimize the potential for contamination. Close or throttle valves, particularly service connections that do not have proper backflow prevention, as needed, to isolate the repair area. If possible, notify impacted customer of the potential disruption. Use caps or covers to protect existing mains or service connections.

3. Excavate the break. Provide the necessary benching, sloping and/or shoring depending on depth and conduct work in accordance with the Occupational Safety and Health Administration (OSHA) standards for trenching and excavation. Install temporary devices to divert surface water runoff around the repair site. Use portable dewatering pumps to maintain water levels at least one foot below the pipe invert during repair.

4. Repair the pipe using the appropriate materials (i.e., fittings, joints, gaskets, clamps), sizes and other necessary repair equipment. During the repair:

    a. Maintain positive pressure, where possible, to prevent contamination from backflow into the pipe. At the start of, at least once during and at the end of the repair, confirm and document if positive pressure is maintained in the immediately vicinity of the break site by visually observing a steady flow or spray of water coming from the pipe, or observation of a hose bib or hydrant located near and at a higher elevation than the break site. Pressure above 20 psi should be maintained outside the immediate repair area. If pipe cannot be repaired under pressure, do no depressurize the pipe until the pipe is exposed.
    b. Maintaining a dewatered trench to at least 1' below the pipe invert.
    c. Visually inspect the interior and exterior of all new materials (pipes, fittings, valves, etc.) to ensure there is no visible damage, debris or contamination.
    d. Remove any visible debris from exposed areas of the existing pipe.
    e. Keeping all parts, tools and materials used in the repair in a clean and sanitary condition. Clean and disinfect prior to use or installation with a 1 percent chlorine solution. If any interior areas of the pipe were exposed to the environment during the repair, spray or swab any accessible upstream and downstream interior of the existing pipe areas with a 1 percent chlorine solution. If the repair requires new piping to be installed in any section, the new pipe must be inspected, cleaned and disinfected from both ends by swabbing with 1 percent chlorine solution.
    f. Maintain pipe caps, plugs or other protective coatings until materials are ready to be installed.
    g. Complete all pipe and fitting joints in the trench before stopping work. If work requires more than one day, store materials on-site in a secure area.

5. If needed, disinfect the pipe in accordance with the described outlined in AWWA Standard C651. For disinfection of repaired mains, the following methods can be used:

    a. Tablet method: involves the use of calcium hypochlorite tables in the repaired or replaced pipe section and contact time with an initial free chlorine concentration of 25 milligram per liter (mg/L). Note that pipe materials must be evaluated for compatibility and that this method may only be used when pipes and appurtenances are kept clean and dry during construction. Cleaning and flushing of the main prior to disinfection cannot be performed with this method.

b. Continuous feed method: involves filling the main with potable water to remove air pockets, then flushing to remove particulates, and refilling the main with chlorinated water at a dose of 25 mg/L until stable concentrations are reached within the pipe (i.e., a free chlorine residual of not less than 10 mg/L after a holding period of 24-hours).
c. Slug method: involves filling the main with potable water to remove air pockets, flushing to remove particulates, followed by slow flush with a high concentration of chlorine – 100 mg/L – for at least 3 hours. The use of cross connection control and backflow prevention must be used to ensure the high chlorine concentration does not affect the distribution system.
d. Spray method: involves a 30-minute exposure to free chlorine at not less than 200 mg/L. Refer to chlorination method 2 in AWWA Standard C652 – Disinfection of Water Storage Facilities.

The slug method may be preferable as it requires reduced contact time. However, alternative methods (tablet method, continuous feed method, or spray disinfection) are available. Evaluate the scene and select the best method for disinfection based on site conditions, length and diameter of the main, type of joints present, available materials and equipment, type of break and associated risk for microbiological contamination. If highly chlorinated water is likely to impact fish or plant life or other downstream users), dechlorination must be performed to neutralize the remaining chlorine residual prior to discharge. If dichlorination is necessary, follow the procedures outlined in AWWA Standard C655 – Field Dechlorination.

6. Target a unidirectional flush towards the water main break. Open the necessary hydrants to complete the flush. Flush with potable water at a velocity of 3.0 feet per second (fps) in the pipe for a minimum of three pipe volumes to remove debris, and verify that the discharge is visually clear.

7. Check for typical system chlorine residual in the main using a field chlorine test kit and flush the pipe section until typical system residuals are detected (i.e., to at least 90% of ambient or pre-break levels and not more than 4.0 mg/L as required by State and Federal regulations). Collect samples from the immediate and surrounding areas around the repair site.

8. For high risk breaks (Types 3 and 4), notify affected customers about the break, schedule, and concerns. Instruct customers to flush their home plumbing after repairs are completed. If contamination was likely to occur, perform issue a precautionary boil water notice. In the event that a boil water advisory is needed, the Water Service Center Supervisor should immediately contact the appropriate staff the Geneseee Coutny Health Department and Michigan Department of Environmental Quality to notify them of the situation and to coordinate the public notification.

9. For medium risk breaks (Type 2) where a full pipe section was required and high risk breaks (Types 3 and 4), conduct coliform sampling in accordance with AWWA Standard C651. For Type 2 and some Type 3 breaks, the main may be returned to service prior to the completion of the bacteriological results. For Type 4 results, await until sample results are received and show the absence of coliforms. In the event that coliforms

organisms are detected, repeat the flushing and resample for coliforms. If the confirmation coliform sample also shows the presence of coliforms, repeat disinfection using the continuous-feed or slug method until no coliform organisms are present. For any positive coliform results, the Water Service Center Supervisor should immediately notify Michigan Department of Environmental Quality and follow any required procedures.

10. Flush hydrants, if needed, to remove any debris.

11. Return the main to service by opening any closed valves, using a sequence that avoids low or negative pressures.

12. Backfill and compact pipe bedding per applicable AWWA pipe installation standard.

13. Repair ground surface to at least original conditions.

6 DATA RECORDING AND MANAGEMENT

Following a main break, enter all necessary information into the EAM system. This includes:

- Date and approximate type of break
- Nature of break (i.e., circumferential, longitudinal, both, shear, hole, split, blowout, joint, sleeve, other)
- Apparent cause of break (i.e., water hammer, defective pipe, corrosion, deterioration, improper bedding, operating pressure, temperature, differential settlement, improper installation, other)
- Type of break (based on Table 1 above)
- Location and field conditions (paved/unpaved, traffic conditions, type of soil, side of street, weather conditions,)
- Pipe data (type of main, class, length, diameter, bedding, backfill, compaction)
- Type of repair (clamp, sleeve, etc.)
- Repair materials used
- Potential contamination issues (e.g., muddy trench water flowing into broken pipe, leaking sewer pipe in trench, catastrophic pipe failure where pipe is open)
- Problems encountered
- Water quality test results
- Field observations, including inoperable valves or hydrants or incorrect locations of mains, valves, hydrants, underground utility locations, service connections, etc.
- Estimate the cost associated with the repair (materials, manpower, time, overtime, etc.)

The Water Service Center Foreman shall assign work orders for any follow-up items, such as valve replacements.

7 REFERENCES

AWWA. (2015). *C651-14 Disinfecting Water Mains.* AWWA

AWWA. (2011). *C652-11 Disinfection of Water Storage Facilities.* AWWA

Kirmeyer, G. J., Thomure, T. M., Rahman, R., Marie, J. L., LeChevallier, M. W., Yang, J., … & Schneider, O. (2014). Effective Microbial Control Strategies for Main Breaks and Depressurization. Denver, CO: Water Research Foundation.