

**From:** Howard Croft [<mailto:hcroft@cityofflint.com>]

**Sent:** Thursday, **September 10, 2015 5:48 PM**

**To:** [edwardsm@vt.edu](mailto:edwardsm@vt.edu)

**Cc:** Michael Glasgow

**Subject:** Water Information

Mr. Edwards,

I appreciate our brief conversation today and look forward to meeting you next week. As promised, I have sent you a copy of our water age map that was developed in January of this year and thought that you may be interested in several of the projects that we have recently completed or that are currently under way.

We have taken a very aggressive approach to develop a capital improvement plan to address our antiquated infrastructure and these are the first steps in our plan. We have encouraged all residents to have their water tested and appreciate the opportunity to share any data that you and your team have accumulated.

Installation of Granulated Activated Carbon to reduce the TOC in the water - **completed**

Valve cycling of over 5000 valves to identify inoperable valves - **completed**

Installation of over 9000 water meters - **in process (1/3 completed)**

Leak detection performed on all 600 miles of distribution main - **in process**

Hydraulic model of the distribution system - **in process**

Enhanced jar testing to help with chemical dosing levels - **ongoing**

Enhanced hydrant flushing to reduce water discoloration - **ongoing**

Annual pipe replacement in identified areas - **planned**

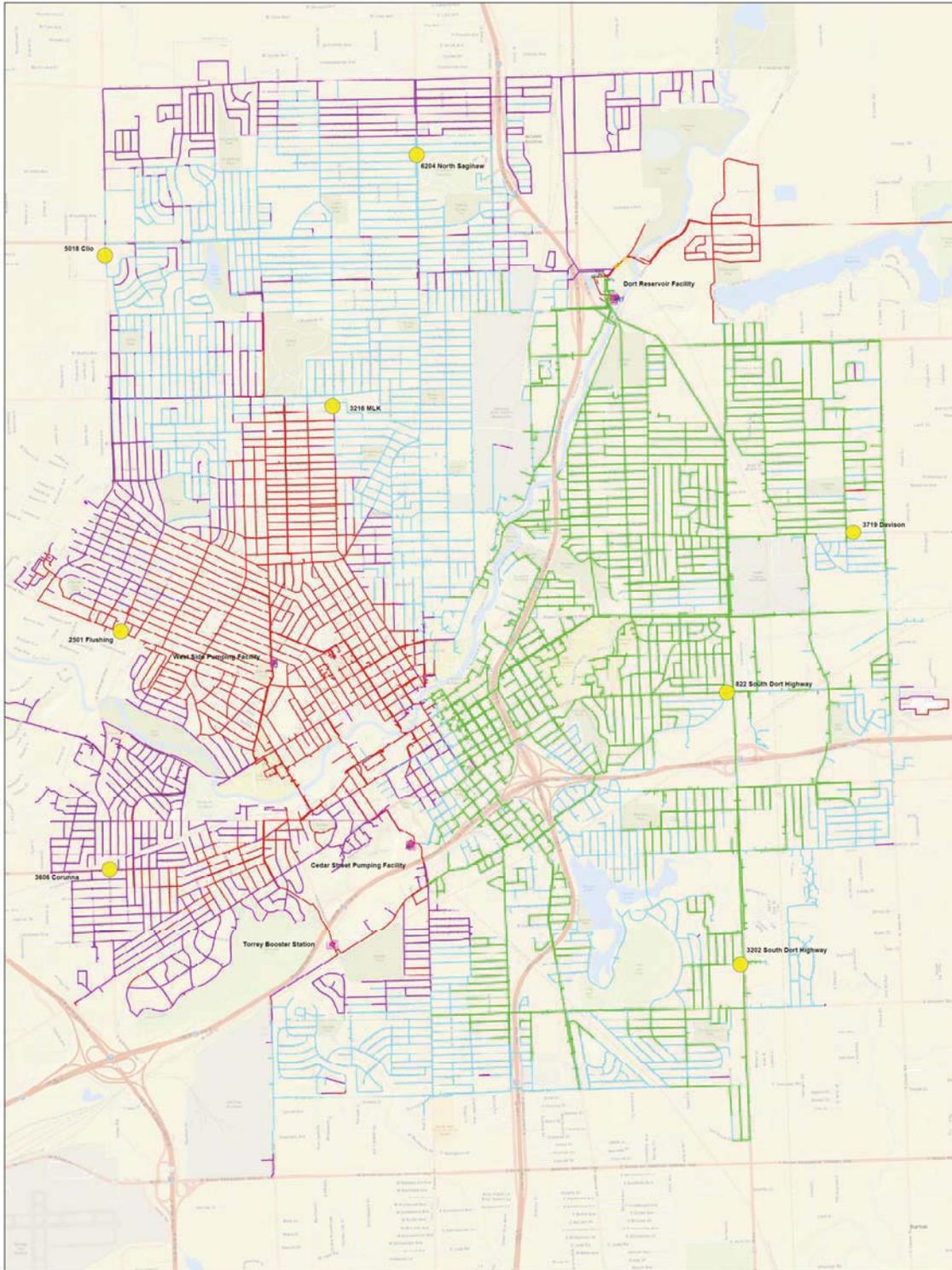
Annual valve replacement in identified areas - **planned**

I will send you a copy of the 2011 Flint River Study once I get it into electronic form.

Thank you,

**Howard Croft**

Public Works Director



**Legend**  
**Water Quality (Hrs)**

- less than 24.0
- 24.0 to 72.0
- 73.0 to 144.0
- greater than 144.0

● Water sample location

## CITY OF FLINT MAJOR WATER INFRASTRUCTURE

### WATER AGE & WATER SAMPLE LOCATION MAP

January 21, 2015



0 550 1,100 2,200 3,300 4,400  
 Feet

On Mon, Sep 21, 2015 at 3:23 PM, Marc Edwards <[edwardsm@vt.edu](mailto:edwardsm@vt.edu)> wrote:

Do you mind if we publish the **water age map** on the web site, or is it for our internal reference work only?

**From:** Howard Croft <[hcroft@cityofflint.com](mailto:hcroft@cityofflint.com)>  
**Sent:** Monday, September 21, 2015 5:15 PM  
**To:** Marc Edwards <[edwardsm@vt.edu](mailto:edwardsm@vt.edu)>  
**Cc:** Michael Glasgow <[mglasgow@cityofflint.com](mailto:mglasgow@cityofflint.com)>  
**Subject:** Re: Water Information

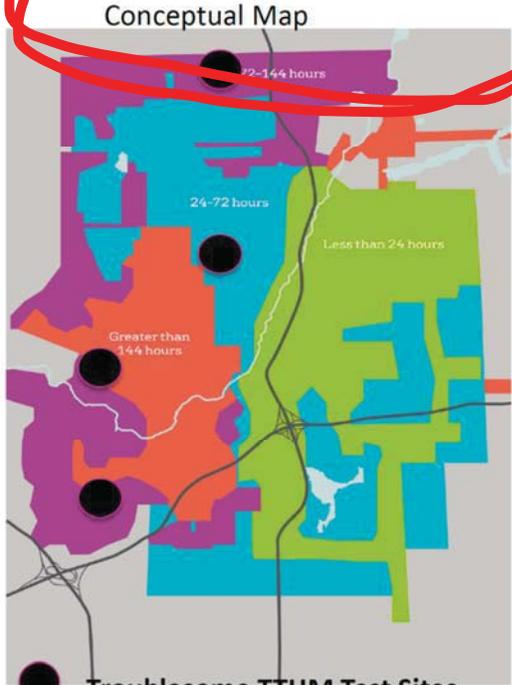
Marc,

My only hesitation is that the water age map was done in January when we were contending with TTHM concerns and may not be completely accurate. We have since implemented several recommendations that have improved the water flow in many of the areas of the City and I would hope there was a way to reflect the positive actions that we have undertaken to improve the system. I have included a report by Veolia that shows a version of the water map on page 10 with recommendations that we have mostly completed. The Veolia report was presented in a public forum making this public information and thereby it should be OK for you to use the map.

Slide 10

## Water Age Map

- Speed up flow of water from plant to homes – 2 weeks plant to house
  - Find closed valves & open them
  - Replace broken valves
  - Update hydraulic model
  - Reduce system storage
- Track customer complaints
  - Test customer water
  - Spot flush hydrants to clean areas of stagnant water in the system



March 4, 2015 Technical Advisory Committee

**From:** Marc Edwards <edwardsm@vt.edu>

**Sent:** Tuesday, **October 13, 2015 2:38 PM**

**To:** [REDACTED]

**Subject:** RE: Can you send me all the data you have and the map?

City said that **water age map is in error**, because dozens of valves are frozen shut, and they are scrambling to upgrade the model.

**Can't use it for anything scientific, only conceptual. Wayne State has a complete model.**

**From:** [REDACTED]

**Sent:** Tuesday, **October 13, 2015 2:55 PM**

**To:** [REDACTED] Marc Edwards

**Subject:** Fwd: Can you send me all the data you have and the map?

**And here is the water age map.** Melissa is working on putting together the latest citizen collected health data. Marc, do we have any more official info that could be helpful?

**From:** Howard Croft <[hcroft@cityofflint.com](mailto:hcroft@cityofflint.com)>

**Sent:** Wednesday, **October 28, 2015 2:28 PM**

**To:** Amy Hovey <[Amy.Hovey@mail.house.gov](mailto:Amy.Hovey@mail.house.gov)>; Andy Leavitt <[aleavitt@senatedems.org](mailto:aleavitt@senatedems.org)>; Anthony Chubb <[achubb@cityofflint.com](mailto:achubb@cityofflint.com)>; Brent Wright <[bwright@cityofflint.com](mailto:bwright@cityofflint.com)>; Darren Lytle <[lytle.darren@epa.gov](mailto:lytle.darren@epa.gov)>; Dayne Walling <[dwalling@cityofflint.com](mailto:dwalling@cityofflint.com)>; donna.cole <[donna.cole@genesys.org](mailto:donna.cole@genesys.org)>; dykema <[dykema@mich.gov](mailto:dykema@mich.gov)>; Eden Wells (DHHS) <[wellse3@michigan.gov](mailto:wellse3@michigan.gov)>; edwardsm <[edwardsm@vt.edu](mailto:edwardsm@vt.edu)>; George Krisztian (DEQ) <[krisztiang@michigan.gov](mailto:krisztiang@michigan.gov)>; ..... Shawn McElmurry <[s.mcelmurry@wayne.edu](mailto:s.mcelmurry@wayne.edu)>

**Subject:** TAC Team Update 10\_28\_15

Team,

The next Technical Advisory Meeting is set for **Wednesday November 18th 2:00 pm** at Flint City Hall. The previous date being considered was Veterans Day and we encountered several conflicts. There will be a call in number available and I will send an agenda prior to the meeting.

There is a significant amount of new information included in this weekly report and I expect that trend to continue as we move forward. Several of the items mentioned such as the specific dosing level of phosphate will become targets of discussion at this next meeting in order to thoroughly evaluate the pros and cons and to help with public information.

The testing map continues to have information added as it becomes available and on the weekly report we have inserted a data table that will be updated regularly as well. Please let me know if anyone is interested in additional data being reported.

Please be prepared to give input on the potential of a December meeting which would have to be December 9th or December 16th.

Thank you,  
**Howard Croft**

Public Works Director  
City of Flint  
1101 S. Saginaw Street  
Flint, MI 48502  
PH# 810.766.7135 Ext.2043  
[hcroft@cityofflint.com](mailto:hcroft@cityofflint.com)



**City of Flint  
Technical Advisory Committee - Weekly Report**

October 28<sup>th</sup>, 2015

Last meeting: 10-7-2015  
Next meeting: 11-18-2015, 2:00 pm

**I. Overview –**

Please note that we have set the date for the next meeting at **Wednesday November 18<sup>th</sup>** 2:00 pm at Flint City Hall (there will be a call in number). The previous date proposed is Veterans Day and there were several conflicts.

| Issue                  | Description  | Action Item  | Owner      |
|------------------------|--|--|------------|
| Corrosion Control      | To help recoat the piping                            | The final design has been sent to MDEQ for peritting.  | LAN        |
| Surge Protection       | Main breaks are down.                                | Leak detection will continue for the next few months.  | City Staff |
| KWA - Prep             | Design and installation of final improvements needed | Internal November 5th meeting scheduled to discuss specifics. See item IV.                     | LAN/City   |
| KWA - Transfer Station | Design for water supply from KWA                     | Internal November 5th meeting scheduled to discuss specifics. See item IV.                     | LAN        |
| Hydraulic Model        | Filling with data                                    | Need to verify broken valve locations for model to be accurate                                 | LAN/City   |
| SCADA Upgrades         | Used to develop automation within the system.        | First phase went in in FY15 second and final phase due to be installed prior to KWA's arrival. | City Staff |

From: Mona Hanna-Attisha [<mailto:MHanna1@hurleymc.com>]  
Sent: Friday, December 04, 2015 9:59 PM  
To: Marc Edwards  
Subject: Water age

The water age map really matches with our ebill map. Do you have some references you can direct me to regarding water age - older the water, the more corrosive, more lead, etc?

Thanks PPB.

Mona Hanna-Attisha MD MPH FAAP  
Director, Pediatric Residency Program

From: Anderson, Nikkia (MSP) <[AndersonN9@michigan.gov](mailto:AndersonN9@michigan.gov)>  
Sent: Wednesday, **January 6, 2016 2:02 PM**  
To: remove <[edwardsm@vt.edu](mailto:edwardsm@vt.edu)>  
Subject: FW: Flint Drinking Water Crisis

Dr. Marc Edwards,

Dr. Mona Hanna-Attisha directed me to you for questions about the Flint Drinking Water Crisis. I work at the Michigan State Police- State Emergency Operations Center, we have been activated due to the Flint Crisis. Our GIS unit has been tasked with producing maps that illustrate the Flint drinking water problem areas, we have already contacted the City of Flint and have been given some of the data for locations of pipelines, some water samples, etc. She emailed us a map of the Water lines and age & sample map that you had produced. Can I ask for clarification on what the Water Age and Samples mean exactly. Do you have the shapefiles for the map that you created, and if so, would you be willing to share this data with us. I thank you in advance for your help.

Any additional information you feel would be useful would also be appreciated.

Nikkia Anderson  
GIS Database Analyst

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From: MSP-SEOCGIS  
Sent: Wednesday, January 06, 2016 2:07 PM  
To: Anderson, Nikkia (MSP)  
Subject: FW: Flint Drinking Water Crisis

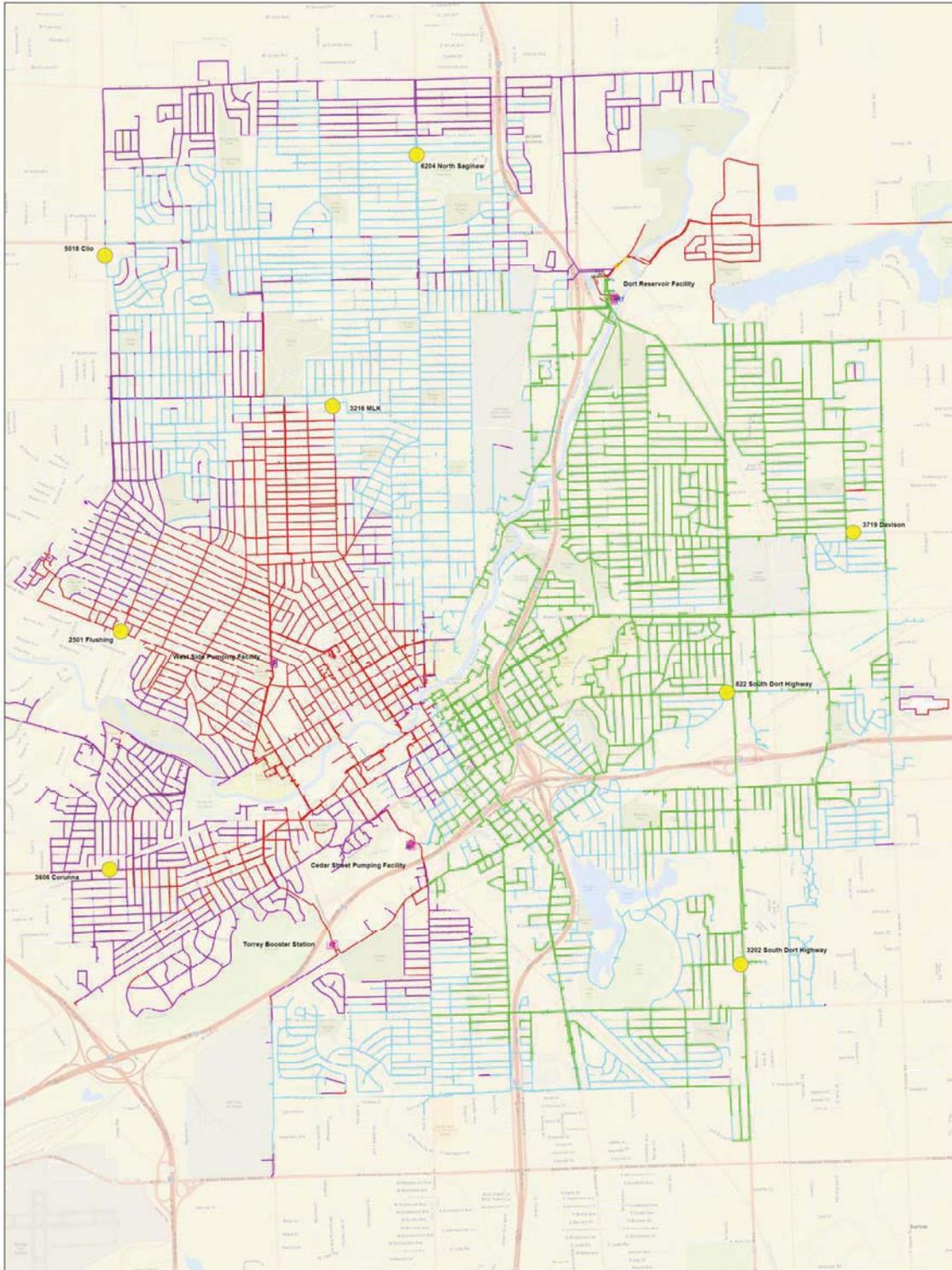
From: Mona Hanna-Attisha [<mailto:MHanna1@hurleymc.com>]  
Sent: Wednesday, **January 06, 2016 1:30 PM**  
To: MSP-SEOCGIS; 'Rick Sadler'  
Subject: RE: Flint Drinking Water Crisis

Thank you for your email. I have cc'd Dr Sadler- Dr Sadler is a MSU Public Health Geographer - he is a flint native and knows every neighborhood in the city. He created the GIS maps for our research (publication link below) and he also communicated yesterday with I think the County Emergency response folks and shared some of our de-identified maps.

I would also direct you to two other map sources - Dr Edwards from Virginia Tech has multiple maps on his website ([flintwaterstudy.org](http://flintwaterstudy.org)) regarding water lead levels and there is also a city of Flint water age map (attached) that highly correlates with increased blood lead and water lead levels. We can probably help get you shape files if needed.

Publication link:  
<http://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2015.303003>

Rick Sadler PhD:



**Legend**  
**Water Quality (Hrs)**

- less than 24.0
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● Water sample location

## CITY OF FLINT MAJOR WATER INFRASTRUCTURE

### WATER AGE & WATER SAMPLE LOCATION MAP

January 21, 2015



0 550 1,100 2,200 3,300 4,400  
 Feet

2/13/2017 (red added)

Delineation of chlorine areas for legionella analysis

To: Masten, Nancy Love,

Cc: Paul Kilgore, Marcus Zervos, Sammy Zahran, Rick Sadler

I am attempting to provide Sammy with temporal and spatial characterization of chlorine levels in the Flint system so this can data can be used to compare against the incidence of LD cases (per census tract). Without the water model to accurately describe the chlorine residual, I am left with two pieces of data:

- 1) Chlorine levels reported in the MOR – this is reported for 10 locations within the water distribution system on a daily basis (not always measured, typically measured at each location about 12 times per month)
- 2) The water age map developed by LAN.

I had Mariana import all the chlorine levels for 2013-2016 (still error checking). The attached water age map shows each of the monitoring locations (includes two pump stations, WS and CS). Here is my thinking for a way forward to allow Sammy to perform his analysis based on the current data we have available (of course this could be improved greatly with a full hydraulic model):

We divide locations into the following three areas:

Low - green water age east of river (Monitoring stations 1,2,3)

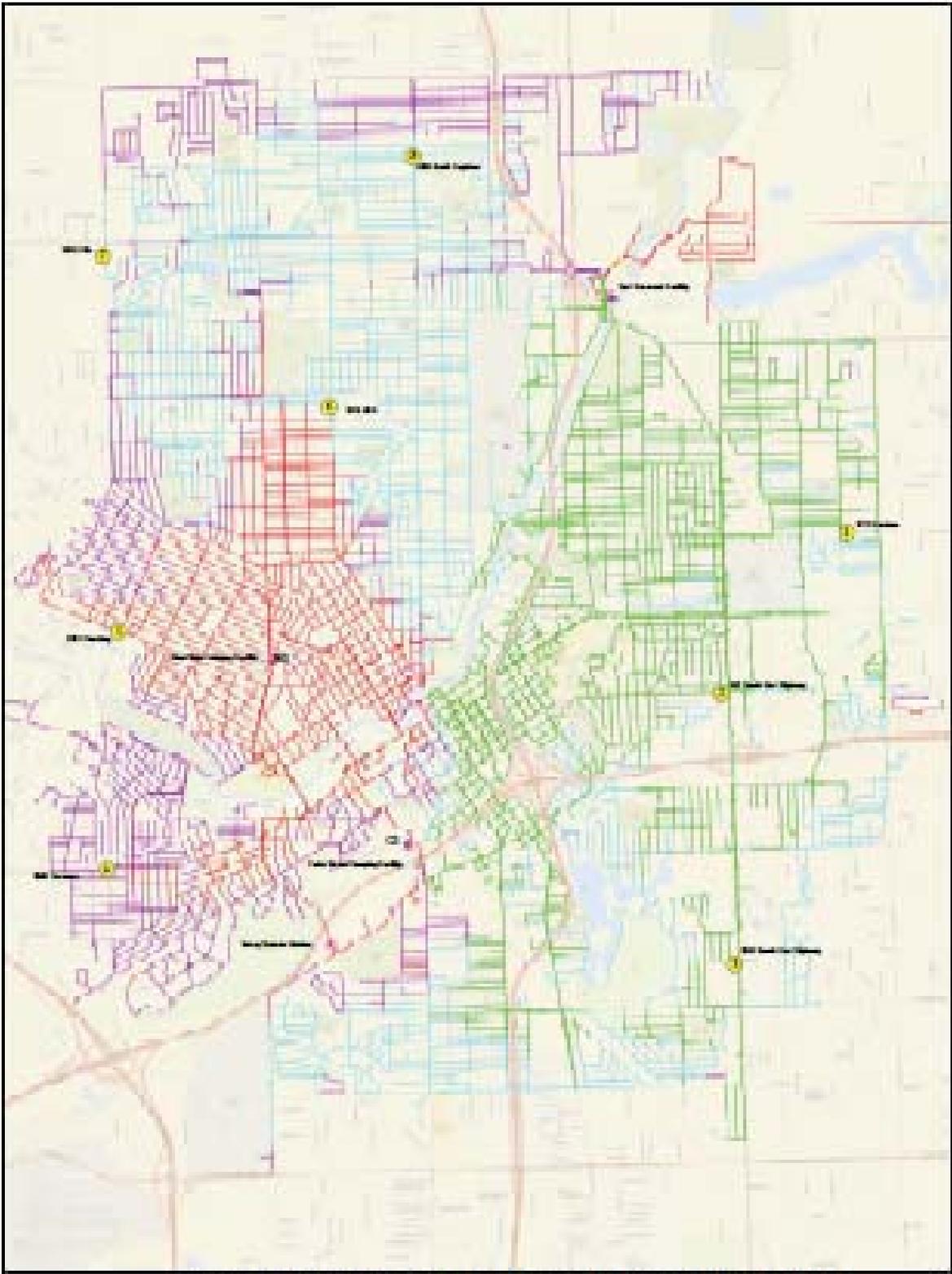
Medium - blue water age northwest (Monitoring stations 7,8)

High - Red and purple area to west (Monitoring stations 5,4)

We then calculate an average chlorine levels for each area on a monthly time step based on the associated monitoring stations. This will allow Sammy to compare 3 hydraulically different areas with temporal variation that is likely to reflect major changes in chlorine levels within the Flint system relevant to Legionella growth.

Does this sound like a reasonable approach given the limited data we have available?

Shawn



- Legend**  
**Water Quality Zone**
- Zone 1 (Purple)
  - Zone 2 (Red)
  - Zone 3 (Green)
  - Zone 4 (Blue)
  - Water Sample Location

**CITY OF FLINT MAJOR WATER INFRASTRUCTURE**  
**WATER AGE & WATER SAMPLE LOCATION MAP**

January 21, 2018



From: Susan J. Masten  
<[masten@egr.msu.edu](mailto:masten@egr.msu.edu)><<mailto:masten@egr.msu.edu>><<mailto:masten@egr.msu.edu>><<mailto:masten@egr.msu.edu>><<mailto:masten@egr.msu.edu>><<mailto:masten@egr.msu.edu>><<mailto:masten@egr.msu.edu>>  
Sent: Saturday, August 5, 2017 7:49:27 AM  
To: Shawn McElmurry; Zervos, Marcus;  
[sadlerr@msu.edu](mailto:sadlerr@msu.edu)<<mailto:sadlerr@msu.edu>><<mailto:sadlerr@msu.edu>><[mailto:sadler  
r@msu.edu](mailto:sadler<br/>r@msu.edu)><<mailto:sadlerr@msu.edu>><<mailto:sadlerr@msu.edu>><<mailto:sadlerr@msu.edu>>  
Cc: Zahran, Sammy; Paul Kilgore; Nancy Love; Michele Swanson; Mushinski, David  
Subject: Re: Draft Retrospective Analysis to be Submitted to Science

Shawn,

Thank you for the opportunity to review the Retrospective Analysis manuscript. Based on a thorough review of the manuscript, I believe that the analysis is seriously flawed and the manuscript is not ready for submission. If you would like, I am willing to work with all of you on revisions. However, if you wish to submit the manuscript in its present form, then, please do not include me as a co-author.

Susan

From: Zahran, Sammy  
Sent: Saturday, August 5, 2017 1:19:47 PM  
To: Susan J. Masten; Shawn McElmurry; Zervos, Marcus;  
[sadlerr@msu.edu](mailto:sadlerr@msu.edu)<<mailto:sadlerr@msu.edu>>  
Cc: Paul Kilgore; Nancy Love; Michele Swanson; Mushinski, David  
Subject: Re: Draft Retrospective Analysis to be Submitted to Science

Hi Susan,

My responses in Blue Font, interspersed below. I will defer to engineers on the team to address domain-specific questions. I pasted remarks from your subsequent email below as well. It would be more efficient for me to talk this out by phone than over email, but I will proceed nonetheless. Also, your thoughts are very much appreciated, as they provide practice against possible/thoughtful objections from other scientists.

SZ

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From: Susan J. Masten  
<[simon.henry.davies@gmail.com](mailto:simon.henry.davies@gmail.com)><<mailto:simon.henry.davies@gmail.com>>  
Sent: Saturday, August 5, 2017 12:06 PM  
To: Zahran, Sammy; Shawn McElmurry; Zervos, Marcus;  
[sadlerr@msu.edu](mailto:sadlerr@msu.edu)<<mailto:sadlerr@msu.edu>>  
Cc: Paul Kilgore; Nancy Love; Michele Swanson; Mushinski, David  
Subject: Re: Draft Retrospective Analysis to be Submitted to Science

Hi Sammy,

<<<<Deleted Text>>>>



To: Zahran, Sammy; Shawn Patrick McElmurry; Marcus Zervos; Sadler, Richard;  
Paul Evan Kilgore; Nancy Love; [mswanson@umich.edu](mailto:mswanson@umich.edu)<<mailto:mswanson@umich.edu>>;  
Mushinski, David  
Subject: Re: Fwd: Re: Draft Retrospective Analysis to be Submitted to Science

Sammy,

>>>Deleted text>>>>>>

Also, EPA has the hydraulic model running - if you could get that from them you would have a far better estimate of water age and therefore chlorine residuals within a tract. Its utility is limited, unfortunately, because we don't know the valving during the period of treatment, but it would be better than the present model.

Susan

**Subject:**Re: Your AJPH article

**Date:**Fri, 8 Dec 2017 09:04:19 -0500

**From:**Susan J. Masten <[masten@egr.msu.edu](mailto:masten@egr.msu.edu)>

**To:**Rick Sadler <[sadlerr@msu.edu](mailto:sadlerr@msu.edu)>

Hi Rick,

If you could send the shapefile that would be great. Thanks so much! One other thing, do you know the date the water age information was generated? I've only see one water age map from Jan 2015, but there may be a lot more. Sorry to ask so many questions - I'm just trying to get a handle on the water age issue.

Thanks again,

Susan