CITY OF FLINT

Dr. Karen Weaver
Mayor

January 31, 2017

Mr. Chris Korleski, Director
Water Division, Region 5
United States Environmental Protection Agency
Ralph Metcalfe Federal Building
77 West Jackson Boulevard (W-15J)
Chicago, Illinois 60604-3590

Sent via Email

Dear Mr. Korleski:

This correspondence is in response to the November 17, 2016 First Amendment to the Emergency Administrative Order ("Order"). Under the amended Order, *Paragraph 60* was revised to require a submittal addressing a *Water Treatment Plant Modification Plan* (*60.b.ii*) and Corrosion Control Study (*60.b.iii*) by February 1, 2017. As co-responders to the Order, Mr. Bryce Feighner (Director – Drinking Water and Municipal Assistance Division, Michigan Department of Environmental Quality (MDEQ)) has reviewed this submittal on behalf of the State and concurs with the content of the document.

Paragraph 60.b.ii of the Amended Order required that a written *Water Treatment Plant Modification Plan* provide a preliminary evaluation of the City of Flint's treatment of its identified new source water. The three specified areas of the *Plan* are presented below:

- An assessment of the treatment processes for the new source water

The City of Flint has previously identified their long-term primary source of supply as the Flint Water Treatment Plant. A component of the secondary/back-up source of supply for the treatment plant would be an on-site raw water reservoir. However, until the construction of these facilities is completed in late 2019, an interim source of supply will be required from either Genesee County or GLWA. Therefore, a treatment process assessment is required for both the primary and interim water sources.

The attached "Flint Water Treatment Plant Improvement Plan" report includes an extensive treatment process assessment for the long-term water source – Lake Huron water treated at the Flint Water Treatment Plant. This report evaluates each unit treatment process within the plant and makes specific recommendations regarding its compatibility, ease of operation, flexibility, efficiency and effectiveness for treating Lake Huron water. Recommended modifications are proposed for the ozone facilities, rapid mix, flocculation, filters, chemical feed and residual solids handling. The recommendations will be finalized during the design phase of the project.

Prior to finalizing the interim water source selection, source compatibility studies will be undertake to determine the impact of the interim source on finished water quality and the Flint water system infrastructure. To enhance water quality and maximize treatment flexibility, Flint will retain its ability to treat finished water at the interconnection of the water systems. While it is anticipated that additional treatment of the interim water source will be minimal, chlorine, sodium hydroxide and/or corrosion inhibitor storage and feed equipment may be required. Since this treatment may extend for up to three years, these chemical feed facilities must be reliable, accurate and simple to operate. The attached report entitled "Proposed Upgrades to Chemical Feed Systems for Purchased Water "addresses how the existing chemical feed facilities will be enhanced to achieve the intended operational goals.

- Identification of necessary Flint WTP infrastructure improvements, including the assessment of associated operation and maintenance needs.

Age, capacity, and maintenance issues have resulted in significant infrastructure (non-process) enhancements being recommended for the Flint WTP. As outlined in the attached "Flint Water Treatment Plant Improvement Plan", the additional/modified pumping and chemical feed improvements account for a significant portion of the proposed construction costs. Replacement of the high service and raw water pumping stations are recommended due to the age and capacity of existing pumps, flow patterns inconsistent with Hydraulic Institute Standards, HVAC issues and other operational concerns. Additionally, a transfer pumping station is being added to allow use of the existing DORT reservoir/clearwell. A new chemical building is also being proposed to house a different combination of chemicals required to effectively treat Lake Huron water. The new chemical feed facilities will enhance the safety, reliability and accuracy of the chemical feed systems.

In addition to the proposed pumping and chemical feed improvements, structural, architectural, electrical and HVAC issues are being addressed throughout the Plant.

Operator training is a key contributor to the successful operation of the modified Flint WTP. The attached document titled "City of Flint – Water System Training Plan "describes the training elements and highlights the completed and anticipated future training. Much of this training is focused on the specific unit treatment processes that will be included in the upgraded Flint WTP. Additionally, appropriate staffing levels, job descriptions, work rules, labor costs, power consumption, chemical use and other operating issues are being developed for the treatment plant.

- A schedule with completion dates for major milestones, including, at a minimum, the following: (1) identifying, securing and utilizing the funding source(s) and (2) implementing the necessary infrastructure upgrades and other identified improvements.

The treatment plant improvements and corrosion/compatibility studies will be funded with WIIN funds through the Michigan DWRF program. If constructed, the on-site raw water reservoir and pumping station will require funds from an alternate source.

DWRF/WIIN funds will be available for the corrosion/compatibility study upon USEPA's approval of the State's Intended Use Plan. To obtain DWRF/WIIN funds for the treatment plant improvements, the DWRF Project Plan submitted in June 2016 must be amended. The necessary additions to the Project Plan will include a description, need for and cost of the Flint

WTP process and infrastructure improvements, an analysis of alternative project approaches and the public participation process. Information is currently being generated to perform this alternative analysis, which should be completed in February, 2017.

A schedule of for the design, permitting and construction of the Flint WTP improvements is included in the "Flint Water Treatment Plant Improvement Plan". Multiple schedules are presented to account for different project delivery and procurement approaches. Project completion dates range from August, 2019 to October, 2020 depending on the implemented project deliver method. A Project Delivery/Value Engineering Workshop is scheduled for February to finalize an approach. Each schedule provides sufficient time for start-up and testing of the facilities.

Paragraph 60.b.iii of the amended Order requires that a corrosion control study be developed for the new source water and that this study be submitted for review and approval by MDEQ and review by USEPA by February 1, 2017. The attached "Flint Corrosion Control Plan" has been submitted to MDEQ (see attached letter) and, upon funding and MDEQ approval is ready for implementation. The proposed study addresses the current water source and how chlorine and phosphate levels should be adjusted as the Flint water system recovers. Additionally, the impact of Genesee County (GCDC) finished water on the Flint system and its blending with future water sources will be evaluated. Extensive corrosion control studies will also be undertaken with the processed water from the modified Flint Water Treatment Plant, when this water is available in 2018.

If you have clarifying questions and/or need additional information, please contact me at (810) 237-2035 or via email at kweaver@cityofflint.com.

Respectfully submitted,

Karen W. Weaver

Dr. Karen W. Weaver
Mayor

cc: Mr. Robert Kaplan, US EPA
Mr. Rich Baird, Governor's Office
Mr. Keith Creagh, MDNR
Mr. Bryce Feighner, MDEQ
Mr. Sylvester Jones, City of Flint

Attachments:
Flint Water Treatment plant Improvement Plant
Flint Corrosion Control Plan
Proposed Upgrades to Chemical Feed Systems for Purchased Water
City of Flint – Water System Training Plan
Transmittal Letter – Flint Corrosion Control Plan

City of Flint
Water System Training Plan

What: Flint Drinking Water Training for Operators and Managers

Who: Initial training (**Phase 1**) will be designed for all staff, new and existing, at all levels of certification. It will include training elements regarding proper operation and maintenance of the existing water system in accordance with distribution system ("S") and limited treatment ("D") license guidance. Instructors will be by industry experts. DEQ staff will participate in certain training elements as instructors and as students.

When: Contacts with industry expert instructors begin October 1, 2016. Frequency: 6 hours per week, 2 hours per day. DEQ will provide the instructors for the "Michigan Safe Drinking Water Act/Rules School" sessions. It is anticipated that this training plan will be completed by June 30, 2017.

Where: Most classes will be held at the Flint WTP or the Distribution Service Center. There will be "hands-on" exercises and possible field trips which may require off-site travel.

Metrics: Certificates will be issued to all students who complete the training indicating the number of contact hours for CEC purposes. An additional metric will be comparing the student's pre and post training levels of certification. The total number of staff to be trained includes 17 currently employed at the WTP, 28 currently employed in the distribution system, and approximately 12 new hires. The City will implement a graduated pay scale that incents water operators to achieve higher levels of certification.

Priority training elements for Phase 1 include (elements shown in red have been completed):

1. Michigan Safe Drinking Water Act/Rules School
2. Disinfection, Bacteriology and Sampling
3. Laboratory Essentials
4. Basic Water Chemistry
5. Corrosion Control
6. Safety – include real disaster stories, emergency plans, OSHA basics
7. Recordkeeping and Reporting
8. Pumps and Motors
9. Operations and Maintenance
10. Hydraulics
11. Customer Service
12. Diversity Training

13. Instrumentation
14. Innovative Distribution Technologies

Phase 2 Training: The City informed the state on September 6, 2016 that the plan for their primary water source is to receive raw water from the Karegnondi Water Authority and treat it using the City's WTP. Therefore, additional training will now be necessary for City employees who will work at the WTP in accordance with filtration ("F") license guidance. This training will primarily focus on the process and facilities that will be included in theproposed improved Flint Water Treatment Plant. This Phase 2 training commenced on November 1, 2016 and includes the following elements (elements shown in red have been completed):

1. Coagulation
2. Flocculation
3. Sedimentation
4. Filtration
5. Disinfection for Surface Water Complete Treatment Plants
6. Innovative Treatment Technologies

The coagulation/flocculation/sedimentation training included:

- Theory of the mixing process and coagulation control
- The design criteria of the existing and future rapid mix and flocculation units
- The operational and regulatory requirements associated with chemical mixing
  - the TOC removal requirements of the DBP Rule and the turbidity removal requirements of the IESWTR
  - the chemistry of alum coagulation
- Theory of sedimentation in water treatment
  - the design and use of plate settlers
- The operational control of the Flint sedimentation units
- The quality characteristics of the incoming KWA raw water supply
- The theory behind jar testing as it applies to Flint's process control schemes

The filtration training included:

- Theory of dual media deep bed filtration
- The design criteria of the existing and the future units at the Flint WTP
- The operational and regulatory requirements of filtration
  - The Interim enhanced SWTR requirements of IFE and CFE monitoring and recording

- The inspection and maintenance of granular media filters

AND

DEPARTMENT OF PUBLIC WORKS
UTILITIES
Water Plant

Dr. Karen Weaver
Mayor

JoLisa McDay
City Administrator

Sylvester Jones Jr.
Water Plant Supervisor

January 23, 2017

VIA EMAIL

Mr. Robert London
Michigan Department of Environmental Quality
401 Ketchum Street, Suite B
Bay City, MI 48708

Dear Mr. London,

In adherence to the First Amendment of the Emergency Administrative Order, the City of Flint is pleased to provide "*Flint Corrosion Control Plan Scope Modifications*" for your review and approval. The document proposes aspects of the corrosion control study that will be performed by Cornwell Engineering Group. The plan focuses on the following items:

- Optimizing corrosion control practices and water system recovery under the current GLWA supply to Flint
- Assessing and addressing the impact of using GCDC-WWS finished water within the Flint system prior to the completion of the Flint Water Treatment Plant improvements
- Developing protocols and a final recommendation for optimized corrosion control for the water produced at the improved Flint Water Treatment Plant and conveyed by the utility's distribution system infrastructure.
- Addressing any water quality issues associated with blending water purchased from GCDC-WWS and water produced at the improved Flint Water Treatment Plant.

Modifications to the Flint Water Treatment Plant mandate that the study be completed in phases. The production of finished water is anticipated in the third quarter of 2018.

If there are questions or concerns, please do not hesitate to contact my office.

Flint Water Plant & Facilities 4500 N. Dort Hwy. Flint, MI 48505 Phone: (810) 787-6537 Fax (810) 787-3710

Respectfully submitted,

JoLisa McDay, Water Plant Supervisor
City of Flint
Water Treatment Plant
4500 N. Dort Highway
Flint, MI 48505

Cc: Mayor Karen Weaver, City of Flint
Mr. Sylvester Jones, Jr., City of Flint
Mr. Bryce Feighner, MDEQ

CDM Smith

Memorandum

To: *John Young*
JoLisa McDay, Water Plant Supervisor, City of Flint

From: *CDM Smith*

Date: *January 25, 2017*

Subject: *Proposed Upgrades to Chemical Systems for Purchased Water*

The City of Flint, Michigan is currently receiving treated water from the Great Lakes Water Authority (GLWA). Prior to distributing the water into the Flint system, sodium hypochlorite and phosphoric acid are being added. The Michigan Department of Environmental Quality (MDEQ) has also requested that the City of Flint have the capability to add sodium hydroxide to raise the pH of the water, if required by the proposed Corrosion Control Plan. Since the water treatment improvements that will allow the Flint Water Treatment Plant (WTP) to treat and distribute water from Lake Huron will not be completed until late 2019, it is anticipated that Flint will utilize these systems continuously for almost three more years. After the Flint WTP is operational, these systems will continue to be used to feed chemicals to any purchased water, if required.

The purpose of this memorandum is to describe the proposed upgrades to the purchased water chemical feed systems at the WTP. The upgrades are proposed to:

- Improve the ability to monitor and control the chemical storage and feed systems.
- Reduce the operator manpower required by implementing remote monitoring and control.
- Improve system safety by eliminating chemical waste and the need for operators to dispose of waste chemicals.

Existing Conditions

The existing chemical storage and feed systems at the WTP for sodium hypochlorite, sodium hydroxide, and phosphoric acid were constructed within a structure on the north portion of the WTP site immediately adjacent to the chemical application points. The sodium hypochlorite and phosphoric acid systems are currently in operation. The systems are manually operated and monitored by the City of Flint's operations staff on an hourly basis.

The chemical storage and feed systems include the following:

- Bulk storage in a 250-gallon vendor supplied tote (Figure 1) without day tanks.
- Spill containment using a polyethylene spill containment pallet (Figure 1).
- LMI solenoid metering pumps and appurtenances (Figure 2). Two metering pumps are provided per chemical operating in a duty/standby mode for redundancy. The phosphoric acid metering pumps are flow paced based upon the purchased water flow.
- Chlorinated polyvinyl chloride (CPVC) piping, valves, and appurtenances.
- Lighting and electric heat.
- Life safety equipment, including a standalone eyewash (Figure 3) and safety shower.
- Chlorine residual and pH analyzers (Figure 4).

Figure 1: Existing Bulk Chemical Storage and Containment (phosphoric acid system shown in photo).

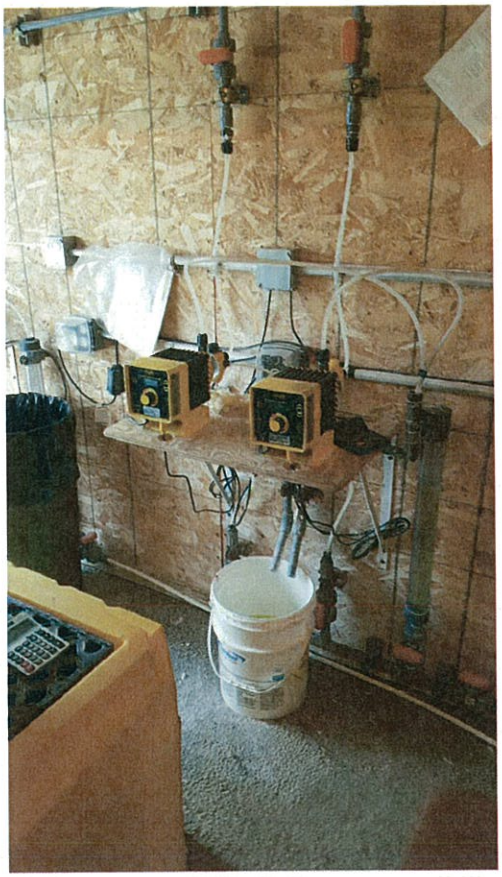

Figure 2: Existing Solenoid Metering Pumps (sodium hypochlorite pumps shown in photo)

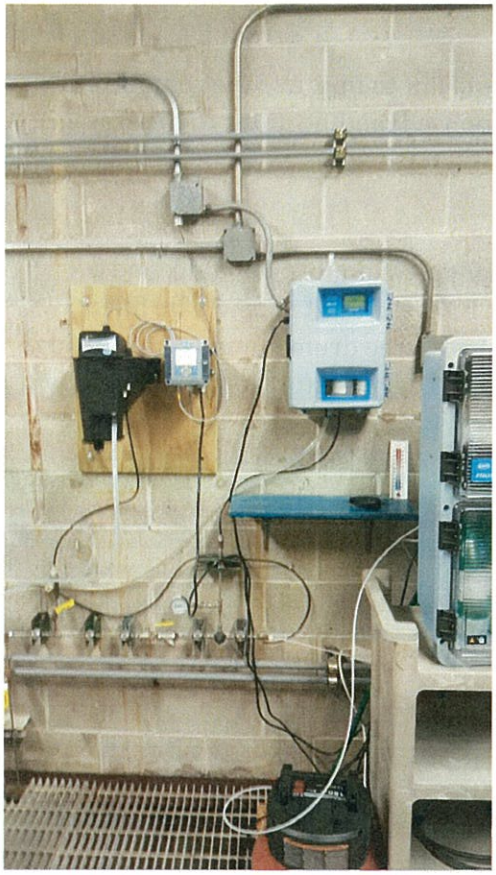

Figure 3: Existing Water Quality Analyzers

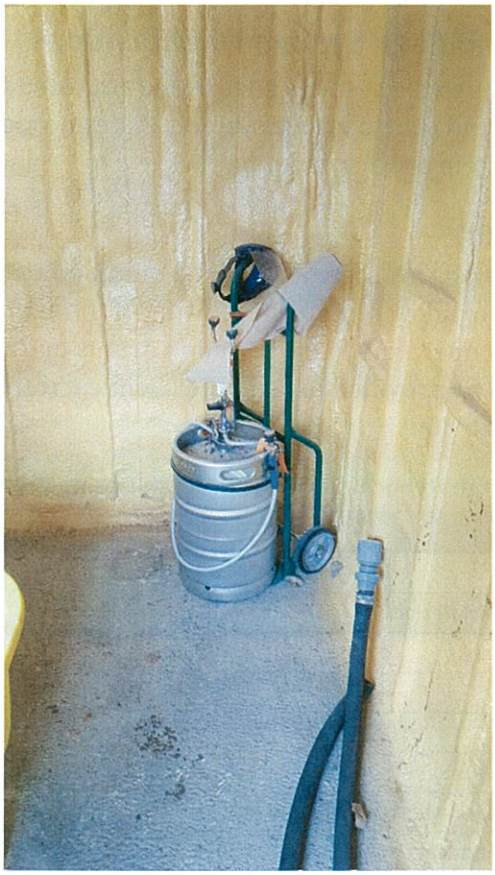

Figure 4: Existing Eyewash

Chemical Properties

The design of the chemical system upgrades will be based upon the chemical properties listed in Table 1.

Table 1: Chemical Properties Used in the Chemical System Upgrade Design

Chemical	Strength (% by Weight)	Specific Gravity	Viscosity at 70°F (centipoise)
Sodium Hypochlorite	12.5	1.165	2.6
Sodium Hydroxide	25	1.278	6.4
Phosphoric Acid	75	1.574	21.5

Storage and Feed System Modifications

Modifications to the systems have been requested by the City of Flint to improve the remote monitoring and control of the systems. A description of the proposed modifications to the storage and feed system are discussed below.

Bulk Storage

The bulk storage arrangement will be modified to include a 250-gallon double wall tank and a weigh scale to allow remote monitoring of the chemical usage. Bulk storage tanks will be filled manually by operators from 55-gallon drums or 250-gallon totes. Three drum pumps (120-V, plug-in type) will be provided to facilitate chemical transfer. Details on the bulk storage tanks are shown in the tables below.

Table 2: Sodium Hypochlorite Bulk Storage Design Criteria

Design Criteria	Unit	Values
Type	-	Vertical, cylindrical, double-walled
Construction Material	-	High-density Crosslinked Polyethylene
Number of Tanks	Number	1
Diameter	Feet-Inches	3'-11"
Height	Feet-Inches	4'-4"
Storage Capacity	Gallons	250
Days of Storage (average dose and flow)	Days	3
Estimated Chemical Usage[1]	Gallons per Day	71

[1] Estimated sodium hypochlorite usage provided by Flint based upon current experience.

Table 3: Sodium Hydroxide Bulk Storage Design Criteria

Design Criteria	Unit	Values
Type	-	Vertical, cylindrical, double-walled
Construction Material	-	High-density Crosslinked Polyethylene
Number of Tanks	Number	1
Diameter	Feet-Inches	3'-11"
Height	Feet-Inches	4'-4"
Storage Capacity	Gallons	250
Days of Storage (average dose and flow)	Days	1.8
Estimated Chemical Usage[1]	Gallons per Day	140

[1] Estimated sodium hydroxide usage based upon a pH increase of 0.2 units and a titration study provided by Flint.

Table 4: Phosphoric Acid Bulk Storage Design Criteria

Design Criteria	Unit	Values
Type	-	Vertical, cylindrical, double-walled
Construction Material	-	High-density Crosslinked Polyethylene
Number of Tanks	Number	1
Diameter	Feet-Inches	3'-11"
Height	Feet-Inches	4'-4"
Storage Capacity	Gallons	250
Days of Storage (average dose and flow)	Days	9
Estimated Chemical Usage[1]	Gallons per Day	26

[1] Estimated phosphoric acid use provided by Flint based upon current experience.

Day Tanks

The existing systems do not have day tanks. Due to the limited storage volume connected to the system and the use of peristaltic metering pumps (see below), the risk of chemical siphoning from the bulk tank to the system can be minimized. Therefore, no day tanks are proposed as part of these upgrades.

Metering Pumps

To allow remote monitoring and eliminate chemical waste in the sodium hypochlorite system, the existing LMI solenoid metering pumps will be replaced. The piping configuration for the LMI solenoid pumps was designed to waste a small volume of chemical into a 5-gallon bucket in an attempt to prevent gas-binding in the pump head. Operators are required to periodically manually dispose of the sodium hypochlorite that accumulates in the bucket.

Due to the potential for off-gassing with sodium hypochlorite, it is recommended that the solenoid pumps be replaced with peristaltic pumps. The design capacity for the proposed metering pumps will be equivalent to the capacities of the existing metering pumps to allow the City of Flint to continue adding chemicals at the dosages required by MDEQ and the proposed Corrosion Control Plan.

The proposed metering pumps will be skid mounted systems containing two peristaltic metering pumps (duty/standby), a calibration column, pressure relief valve, pressure indicator, high pressure switch, ball check valve, back pressure regulator, and isolation valves. The design criteria for the proposed metering pumps are shown in the tables below.

Table 5: Sodium Hypochlorite Metering Pump Design Criteria

Design Criteria	Unit	Values
Type	-	Peristaltic
Number	Number	2 (Duty/Standby)
Construction Material of Tubing Element	-	Thermoplastic Elastomer
Nominal Capacity Range (per pump)[1]	Gal/hr	10
Power	HP	Fractional
Power	Volts	120
Drive Type	speed	Variable Frequency Drive

[1] Pump capacity to be confirmed during detailed design.

Table 6: Sodium Hydroxide Metering Pump Design Criteria

Design Criteria	Unit	Values
Type	-	Peristaltic
Number	Number	2 (Duty/Standby)
Construction Material of Tubing Element	-	Thermoplastic Elastomer
Nominal Capacity Range (per pump)[1]	Gal/hr	10
Power	HP	Fractional
Power	Volts	120
Drive Type	speed	Variable Frequency Drive

[1] Pump capacity to be confirmed during detailed design.

Table 7: Phosphoric Acid Metering Pump Design Criteria

Design Criteria	Unit	Values
Type	-	Peristaltic
Number	Number	2 (Duty/Standby)
Construction Material of Tubing Element	-	Thermoplastic Elastomer
Nominal Capacity Range (per pump)[1]	Gal/hr	6.6
Power	HP	Fractional
Power	Volts	120
Drive Type	speed	Variable Frequency Drive

[1] Pump capacity to be confirmed during detailed design.

Piping Systems

The existing piping between the metering pumps and the application points is in good condition and will be reused. New piping will be provided between the bulk storage tank and the metering pumps. Piping will be solvent welded Schedule 80 CPVC. Non-silica containing cement (heavy duty, industrial grade, gray cement specifically formulated for sodium hypochlorite and sodium hydroxide) will be used for these systems to reduce the potential for leakage at the pipe joints.

Application Points

Chemicals are applied near the flow meter and valve controlling flow into the distribution system from GLWA. Currently, sodium hypochlorite and sodium hydroxide share an application point. Phosphoric acid has a separate application point.

Separate injection points are recommended for each chemical with injection quills. The chemical application points will be modified to utilize removable injection quills to facilitate maintenance activities. Two spare injection quills will be provided to allow periodic removal of any calcium carbonate scale formed from adding sodium hypochlorite and sodium hydroxide to moderately hard water.

Ancillary System Improvements

The chemicals are housed in a pre-fabricated structure constructed on a concrete slab-on-grade with insulated walls. Access to the storage and feed areas is provided through two roll-up doors. The existing space is heated using one electric unit heater per area.

The electrical and HVAC systems are adequate for the existing structure and the needs of the chemical systems; therefore, no upgrades are proposed.

Control System Modifications

The existing systems are fully monitored and controlled via hourly visits from plant operations staff. The City of Flint desires to provide a more robust remote monitoring and control as part of the upgrade to these systems. The existing SCADA system will be upgraded to allow remote monitoring and control from the WTP Control Room as listed below:

- A weigh scale with the new bulk storage tanks, so that daily chemical usage and volume can be remotely monitored and reported.
- Automatic flow pacing of the metering pumps will be provided to allow the metering pumps to automatically adjust the chemical feed rate during flow rate changes.
- Metering pumps will be configured to provide a general alarm back to the SCADA system to alert operators to general issues with the metering pumps. Other alarms will include high discharge pressure, hose failure, and motor failure.
- Chlorine residuals and pH are locally monitored at the device. Remote monitoring of chlorine residuals and pH will be provided in the SCADA system. Alarms will be programmed to alert operators should the chlorine residual or pH be outside a preset range.
- Should the chlorine residual or pH fall outside the preset range as discussed above, operators will have the capability to make remote chemical dose adjustments (manually initiated in SCADA).

- Three new screens will be provided in the plant's existing SCADA system to facilitate remote monitoring and control as discussed above.

CORNWELL
ENGINEERING GROUP

FLINT CORROSION CONTROL PLAN

SCOPE MODIFICATIONS

Cornwell Engineering Group (formerly EE&T)

December 19, 2016

As part of on-going activities several items have occurred that require additional services and attention. Based on recent discussions and requests, the following items will be addressed:

1. Current corrosion control (CCT) evaluations on existing Flint system.
2. Address corrosion plan and issues when County water is fed to Flint prior to Flint plant start up. This addresses Flint distribution system moving to 100% County water for some time period after getting off Detroit water. Depending on County CCT, coagulant used, and water quality, treatment may be needed to the incoming County water to be compatible with the current Flint infrastructure. Tasks 1 and 2 will take place as soon as possible in 2017.
3. Develop corrosion control plan for permanent Flint treatment plant. This is planned for 2018 to 2019 time period.
4. Address future mixed Flint and County water. This addresses a future condition when Flint will primarily be on its new plant but some County water will need to be bled into the system to maintain pipe flows. Therefore parts of Flint system could see different water blends. Depending on County CCT, coagulant used, and water quality; treatment may be needed to the incoming County water to be compatible with the Flint treated water. This item is different from item 2 in that it is not 100% County water but a blend of two different waters and this will involve the water from the new Flint Water Treatment Plant (WTP). This task will also be in the 2018/2019 time frame.

The approach to each of these issues is detailed below.

1. <u>Current corrosion control evaluations on existing Flint system.</u>

   Currently Flint is obtaining water from Detroit and adding chlorine and orthophosphate. It is expected that Flint will continue to receive this water until October 2017. Current orthophosphate doses are based on non-Flint specific laboratory data. Ideally pipe loops would be conducted to optimize the orthophosphate dose. However, the time remaining that this water

will be used does not justify the time and expense of a pipe loop study. Therefore three other actions will be completed:

A. **Continue and finalize data analysis**. Over the past year, DEQ and EPA have collected significant data on lead, other metals, water quality parameters (WQPs) and plumbing materials. Data analysis will continue to be performed on the databases to assess current successes or deficiencies, if any, in the current CCT program.

B. **Coupon studies.** As a replacement for loop studies using Detroit water, coupon studies will be conducted. Coupon studies when conducted properly can be useful for relative comparisons, for example different orthophosphate doses. We have developed our in-house procedures for batch laboratory tests that have shown to be reliable. Briefly, batch coupons are set up in duplicate for each condition (orthophosphate dose, pH, etc.). The water is changed twice weekly for 5 to 6 weeks with lead samples collected each time the water is changed. Recommended orthophosphate doses to test are 2.0, 2.5, 3.0, 3.2, 3.5, and 4.0 mg/L as PO_4, bracketing the current required minimum (3.1 mg/L as PO_4). Each test is performed in duplicate for the six doses — 12 tests.

C. **House flushing.** Based on preliminary data analysis it appears that Flint residents still experience occasional high lead levels, likely due to particulate lead. Orthophosphate is expected to have minimal impact on release of particulate lead. Therefore, the Cornwell Engineering Group will develop protocols and help implement whole house unidirectional flushing to help remove particulate lead from the household plumbing and service piping. This will be based on Cornwell Engineering Group (EE&T) WRF research work. We budgeted for us to help conduct the first two flushing events in order to train Flint staff to be able to perform the remaining events. We included lead analysis cost for the first two sites. We also included time to review future data collected by the City.

D. **Final Deliverables**. Recommended orthophosphate doses and WQPs for the remaining use of Detroit water. House flushing protocols to reduce particulate lead spikes. Deliverable includes on-site presentation of recommendations.

2. <u>Address corrosion plan and issues when County water is fed to Flint prior to Flint plant start up.</u>

This addresses Flint distribution system moving to 100% County water for some time period after getting off Detroit water. Depending on County CCT, coagulant used, and water quality, treatment may be needed to the incoming County water to be compatible with the current Flint infrastructure.

A. County Data. Coordinate and work with the County to obtain their treatment data and their OCCT plan and data.

B. **Desktop Study**. Using traditional desktop, solubility information conduct a desktop study based on projected County finished water quality and current Flint water.

C. **Coupon Study.** A coupon study will be conducted on by first equilibrating coupons using existing Flint water. After the coupons have equilibrated, simulated County water will be introduced into the coupons. The County water will be prepared based on recommended conditions from the County data and their OCCT studies. Measurements will then be made on impacts, if any. The protocol may include chemical adjustments to County water as deemed appropriate. All tests are in triplicate—original coupons plus County as received plus 3 altered conditions –12 coupons, extended time period.

D. **Switch Over Plan.** A plan will be developed and presented on how to accomplish and possibly phase in a switch from current Flint (Detroit) water to County water.

E. **Startup Assistance and Data Review.** When the switch is made we will be available to assist in the switch over and review data during the transition. Approximately 2 months of assistance is anticipated. Assistance includes on-site time during the switch and two additional trips.

3. Develop corrosion control plan for permanent Flint treatment plant.

We will work with the engineering firm selected for design of WTP modifications (WTP design firm) and the City to understand the final treatment selected for the Flint WTP. We will conduct a desktop study, coupon screening study, and pipe loop study. Water will be obtained from the full-scale plant when available in approximately the 3rd quarter of 2018. Task force recommendations for the loop study will generally be followed. Note that there have been discussions of County pipes being added to the pipe loop at Flint. At this time we have not added any scope items for County pipes as details have not been worked out.

A. **Desktop Study.** Using traditional solubility information, conduct a desktop study based on projected City finished water quality. This will include interaction with the City and WTP design firm on likely treatment methods.

B. **Coupon Study**. A screening coupon study will be conducted on finished Flint water to assess the range of reasonable orthophosphate doses. Five orthophosphate doses will be tested in duplicate— 10 tests.

C. **Loop Study**. The existing Flint pipe loop will be used for testing. We plan to follow the task force recommendations which are summarized as follows:

"When a final water quality target is determined, the target finished water would become the source water to feed into the lead (and metal) pipe rigs, and thereafter

the optimization of phosphate dosing would be done on the stabilized exhumed lead pipes in the pipe rigs.

One to two people will be required to be on-site to perform periodic chemical analyses and operate and maintain the pipe rig system, as well as to troubleshoot/repair any problems and to collect samples.

Instruments for pH and colorimetric tests (chlorine residual, orthophosphate) will be needed on site. It is anticipated that the design will include a "control" loop and loops with possibly 3-4 different dosages, in duplicate."

If necessary, pH will be adjusted as part of the pipe loop testing—only one pH will be tested.

We included cost for a full-time operator to be on site to run the pipe loop and take all samples. Analysis of lead samples was also included. We will need a place to work, internet access and a supply of water. We did not include any equipment or modifications to the pipe loop itself. We will identify the required items and they can be procured with the water treatment upgrade project. The base cost assumes a 9 month pipe loop operation. An additional per month cost was also included.

D. Deliverables. Recommended OCCT for the permanent Flint treatment plant. A presentation is included on the recommendations.

E. Startup Assistance. When the switch is made we will be available to assist in the switch over and review data during the transitions. Approximately 2 months of assistance is anticipated. Assistance includes on-site time during switch and two additional trips.

4. Address future blending of County water into the Flint System.

This addresses a future condition when Flint will primarily be on its new plant but some County water will need to be bled into the system to maintain pipe flows. Therefore parts of Flint system could see different water blends. Depending on County CCT, coagulant used, and water quality, treatment may be needed to the incoming County water to be compatible with the Flint treated water. This item is different from item 2 in that it is not 100% County water but a blend of two different waters including water from the new Flint WTP. The final test plan may be altered based on results and findings from the previous tasks.

A. **Desktop Study**. Using traditional desktop, solubility information conduct a desktop study based on projected County finished water quality and Flint finished water.

B. **Coupon study**. A coupon study will be conducted on different blends of County finished water and City finished water to assess any impacts associated with blending the sources. It is anticipated that this will be completed on County and City water alone and at 4 blends using the CCT of each water system. These will be done in duplicate – 12 tests.

C. **Final Deliverable.** Recommendations, cautions and protocols on how to blend County water and Flint water. This may include recommendations for treatment to County water.

COSTING ASSUMPTIONS

A. For the coupon studies it is assumed Flint will send sufficient water to the Cornwell Lab. All lead analysis will be performed as part of Cornwell work so as to obtain quick turnaround.

B. For the loop studies the following is assumed:

1. Cost for repairs, if any, to the existing loops are not in the base price.
2. Cornwell Engineering Group will provide full time on-site operator for the loop studies (9 months in initial budget). Operator will maintain flows and system, take daily water quality samples such as pH, alkalinity, ORP, orthophosphate using our equipment.
3. Cornwell Engineering Group will take lead samples, filter for dissolved versus total, and have lead analyzed.
4. Flint will operate full scale plant to waste to provide water for loop study.
5. Cornwell Engineering Group will set up all protocols, data forms, visit the loops once monthly by a manager-level person, analyze all data results, provide monthly updates and make final recommendation.
6. Loop Costing --- assumes 9 month test. Engineer and two managers on site first two weeks for final set up. One manager to visit once a month. Engineer allocated full time on site for 9 months for operation, sample collection, data analysis and updates and coordination and final report. Managers allotted 16 hours per month each for oversight and 24 hours for final report.
7. County Pipes—no additional time included for addition of County pipes to the Flint pipe loop.

C. Final data analysis, item 1A above—original budget was $28,000 for data analysis. There was much more data to assess than anticipated. To date approximately $55,000 has been spent. The budget increase is to cover the extra $27,000 already expended (as of December 1) and to complete the analysis.