EXHIBIT 9

Lead and Copper Corrosion Control Optimization Study

Volume 1 of 2 – Final Report

prepared for

Detroit Water and Sewerage Department

Contract No. CS-1171

prepared by

Tucker, Young, Jackson, Tull, Inc., in association with CH2M HILL, INC., and Economic and Engineering Services, Inc.

May 1994

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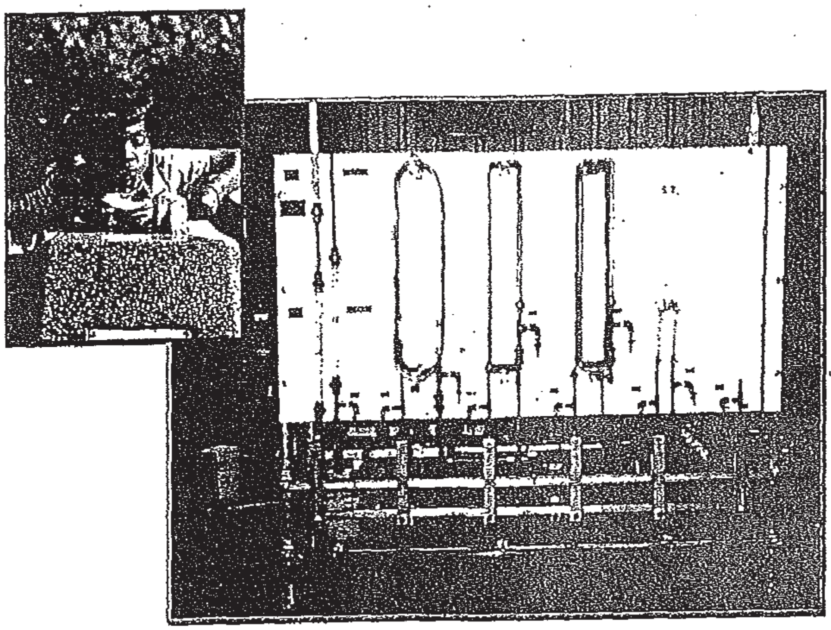
Lead and Copper Corrosion Control Optimization Study



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WATER & SEWERAGE DETROIT DEPT.

Detroit Water and Sewerage Department

Introduction

As a result of the Safe Drinking Water Act (SDWA) Amendments of 1986, the U.S. Environmental Protection Agency (EPA) published final drinking water regulations for lead and copper in the June 7, 1991, *Federal Register*. Those regulations, known as the Lead and Copper Rule (LCR), require:

- Tap water monitoring, which is a new approach for water utilities
- Treatment optimization for lead and copper corrosion control
- Public education and lead service line removal if utilities exceed preset lead or copper levels

Large utilities, serving populations greater than 50,000, are required to conduct corrosion control studies to demonstrate that they are either already providing optimal treatment or to determine optimal treatment for their system.

DWSD made necessary public notices and embarked on studies to develop optimal treatment solutions.

In response to the regulations, the Detroit Water and Sewerage Department (DWSD) conducted two rounds of monitoring at home water taps for lead and copper and throughout the distribution systems for other water quality parameters. Monitoring was a cooperative effort between the DWSD, wholesale water customers, and the Michigan Department of Public Health (MDPH). Copper levels were well below EPA limits. Lead levels, however, exceeded EPA action levels (ALs) and DWSD made necessary public notices and embarked on studies to develop optimal treatment solutions.

Lead exposure sources for humans include air, food, dust, paint, and drinking water. Elevated lead levels in blood have been associated with adverse health effects in humans. Federal health authorities have many programs to reduce lead exposure including low-lead gasoline and reduced lead content in paint. Although drinking water may not be the major source of lead, reducing lead levels in drinking water will have a positive health benefit. An additional benefit of corrosion control is prolonged life for water distribution pipes and home plumbing. This results in lower costs for water utilities and their customers.

In March 1992, the DWSD contracted with Tucker, Young, Jackson, Tull, Inc. (TYJT), in association with CH2M HILL, INC., and Economic and Engineering Services, Inc. (EES), to perform a lead and copper corrosion control study. The purpose of the study was to determine the optimal approach for reducing lead and copper concentrations in DWSD drinking water without adversely affecting other water quality characteristics. Major tasks in this study were to:

- Evaluate existing water quality data, existing distribution system pipe materials and the results of lead and copper sampling
- Identify and analyze feasible and practical treatment methods to reduce lead and copper corrosion (desktop analysis)
- Design and construct a pipe-loop testing apparatus to evaluate treatment alternatives identified in the desktop analysis

- Operate the pipe loops for 1 year to evaluate selected corrosion control treatments on different pipe materials
- Evaluate the effectiveness and feasibility of the tested treatment alternatives in reducing lead and copper concentrations
- Recommend an optimum lead corrosion control treatment
- Develop an implementation plan for full-scale corrosion control facilities

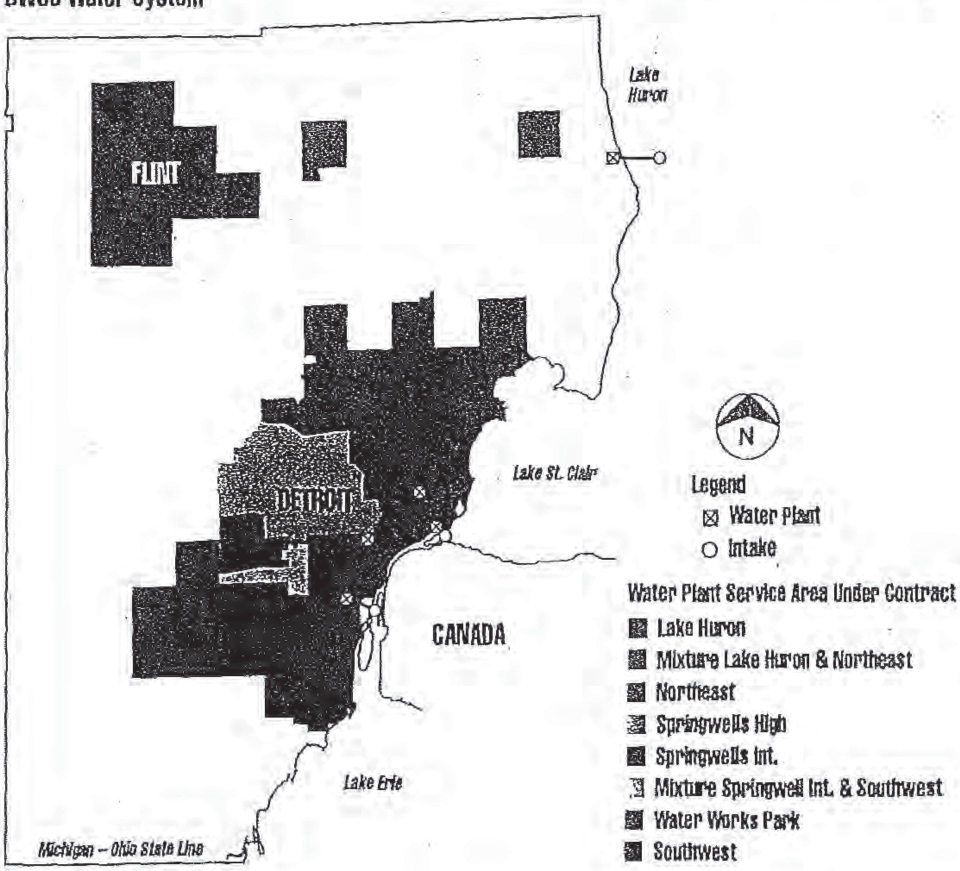
This report presents the results of the DWSD Lead and Copper Corrosion Control Optimization Study.

Existing Conditions

The DWSD obtains water from three intakes. Two of these, the Belle Isle and the Fighting Island Intakes, take water from the Detroit River. The third intake is on Lake Huron. Water is treated at five water treatment plants (WTPs) including the Water Works Park, Southwest, Springwells, Northeast, and Lake Huron WTPs. The water system is shown in Figure ES-1. Treated water from the 5 WTPs is distributed to the City of Detroit and 119 wholesale water customer systems. The DWSD water system serves about 4 million people.

Water leaving the WTPs is of good quality and considered moderately

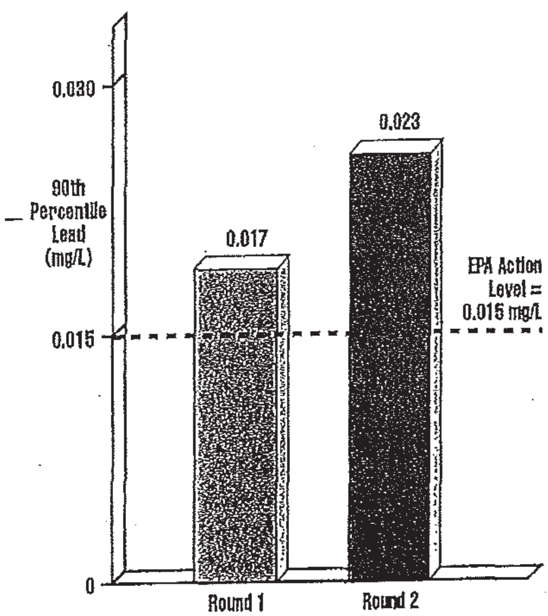
Figure ES-1
DWSD Water System



corrosive. For example, pH from the five WTPs averages 7.4, alkalinity averages 76 mg/L ($CaCO_3$), and hardness averages 100 mg/L ($CaCO_3$). Nevertheless, some increase in lead and copper is resulting from the corrosive action of the water, primarily on service pipe and household plumbing. The main sources of lead are 50:50 lead/tin solder, brass containing lead used in faucets, and lead service lines and plumbing.

The regulation lead AL is 0.015 mg/L at the 90th percentile in home water taps. During the LCR Compliance Monitoring conducted in 1992, DWSD's 90th percentile lead concentration was 0.017 mg/L in the first round and 0.023 mg/L in the second round of sampling (Figure ES-2). Looking at the data in a slightly different manner, 35 to 37 percent of the 119 purveyor water systems exceeded the AL for lead.

Figure ES-2
LCR Compliance Monitoring Results for Lead



For copper, the 90th percentile concentrations were 0.34 and 0.19 mg/L for two rounds of sampling–well below the copper AL of 1.3 mg/L (Figure ES-3). Lead uptake, therefore, is the major concern within the DWSD water system.

Determining the optimal lead control treatment is essential; it is the objective of conducting this corrosion control study. Further, there are an estimated 200,000 lead service lines (LSLs) in DWSD's direct service area and possibly more in areas served by wholesale customers. After corrosion treatment is optimized, the possibility exists that lead ALs may still be over 0.015 mg/L at the 90th percentile. Should this occur, the DWSD would need to embark on a removal program for LSLs, which could cost between $300 and $800 million.

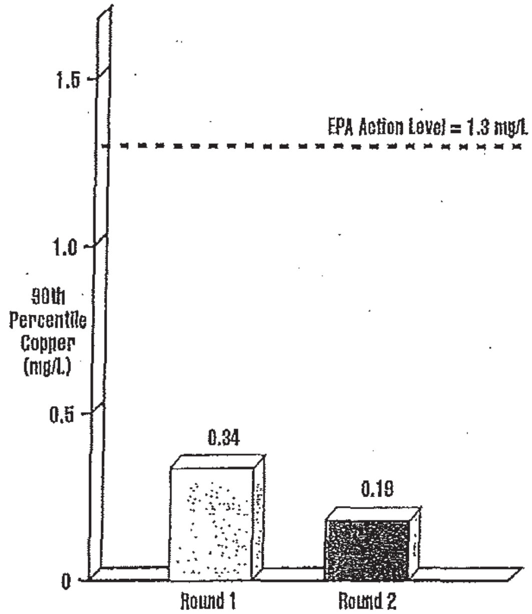
Desktop Analysis

To reduce the number of chemicals for long-term testing, a screening analysis was performed using desktop techniques recommended by U.S. EPA. Lead corrosion control treatment methods examined for their applicability to DWSD are as follows:

- Polyphosphates
- Orthophosphates
- Zinc orthophosphate
- Polyphosphate/orthophosphate blends
- Silicates
- pH adjustment
- Alkalinity adjustment
- Calcium adjustment

The main criteria for selecting a lead corrosion control method is performance for lead uptake reduction. Lead corrosion control methods were also evaluated

Figure ES-3
LCR Compliance Monitoring Results for Copper



based on effects on other drinking water regulations, industrial water users, wastewater treatment, water quality, water treatment operations, consecutive water systems, and multiple sources of supply and treatment.

Based on this evaluation, the following chemical treatments were eliminated from consideration for pipe-loop testing.

- **Polyphosphates.** These products are primarily used to sequester iron, calcium, and manganese and may actually do more to promote lead corrosion than to prevent it.
- **Polyphosphate/Orthophosphate Blends.** These products have not been proven to be more effective than orthophosphates alone for lead reduction, and their proprietary chemical composition makes selection of the optimum product difficult.
- **Silicates.** Sodium silicate inhibitors require a high dosage for lead control and, based on a survey of major industries, would have significant adverse effects on industrial water users.
- **Alkalinity Adjustment.** This technique would have marginal performance for lead reduction based on DWSD water quality and would be impractical for a system the size of DWSD.
- **Calcium Adjustment to Deposit a Calcium Carbonate Layer.** This technique is not a proven method for lead reduction, and would be difficult to produce a uniform layer throughout a distribution system the size of DWSD. Calcium carbonate deposition, however, can occur when pH is raised for lead reduction. This situation is addressed under the pH adjustment alternative.

Lead corrosion control treatment methods applicable for DWSD water are as follows:

- **Orthophosphates.** These products have been shown to be an effective means of lead reduction for water similar to that of the DWSD.
- **Zinc Orthophosphate.** These products are also a proven method of lead reduction, although there is concern about zinc in industrial water and wastewater.
- **pH adjustment.** This technique is also a proven method of reducing lead solubility, although higher pHs affect some industrial users and can increase calcium carbonate deposition.

A survey of 16 Great Lakes area water utilities using water of similar quality to that of DWSD demonstrated the effectiveness of orthophosphate, zinc orthophosphate, and pH adjustment in reducing lead concentrations at the consumers' taps. Those treatment methods, therefore, were retained for further testing in the pipe-loop apparatus.

Pipe-Loop Testing

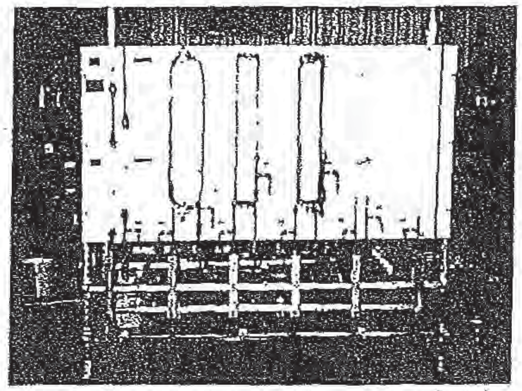
Based on the desktop analysis, it was concluded that the following treatments would be tested in the pipe loops:

- Adjusting pH to 8.1 using sodium hydroxide
- Adjusting pH to 8.7 using sodium hydroxide
- Adding zinc orthophosphate at doses of 0.4 mg/L for zinc and phosphorous (as P)
- Adding orthophosphate using phosphoric acid at a dose of 0.4 mg/L as P

Pipe-loop testing produces information on the corrosion control treatment most likely to effectively reduce lead levels.

It is important to understand that pipe-loop testing is conducted to provide information on the relative effectiveness of corrosion control treatments. The results cannot be used to predict actual lead levels that may occur at customers' taps in the water system. Pipe-loop testing, however, produces information on the corrosion control treatment most likely to effectively reduce lead levels and is an approved optimization technique.

Figure ES-4
Typical Testing Apparatus



A pilot-scale testing apparatus was designed and constructed to test each of the treatment techniques on different pipe materials. Five pipe-loop racks were constructed: one for each of the four methods and another for control (no treatment provided). Each pipe-loop rack included one new lead pipe loop, two identical copper pipe loops with lead soldered joints, one brass tester, and one section of old lead pipe. Three weight loss testers were also included for measuring corrosion rates of steel, galvanized steel, and copper. A typical testing apparatus is shown in Figure ES-4.

The pipe-loop facility was installed in the lower level of the Water Works Park High Service Pump Station and operated from January to November, 1993. After an initial period of passivation, water samples were collected on a weekly basis and analyzed for lead, copper, and zinc. The 1-liter water samples were taken after the water had been in contact with the pipe loop materials for 8 hours. This was done to represent the first-draw sampling required by the LCR. Additional sampling included daily monitoring for pH, chemical doses, and temperature. Disinfection by-products (DBPs) and pipe insert weight loss were done quarterly. Flavor profile analyses to assess any changes in tastes or odors were run monthly.

Results of pilot testing indicated:

- The inhibitor treatments, zinc orthophosphate, and phosphoric acid are statistically better than the untreated control for both old and new lead piping (Figure ES-5).
- For lead solder and copper piping, the median lead levels were lowest in the water with inhibitors (zinc orthophosphate and phosphoric acid), but only the phosphoric acid results were statistically better than the other loops (Figure ES-6).
- For brass, the results indicated that the treatments were no better than the control; however, lead levels were near the detection limit in the brass testers (Figure ES-6).
- Zinc orthophosphate and phosphoric acid were also found to be the most effective treatments in reducing copper (Figure ES-7).

Figure ES-5
Relative Lead Levels from Lead Pipe

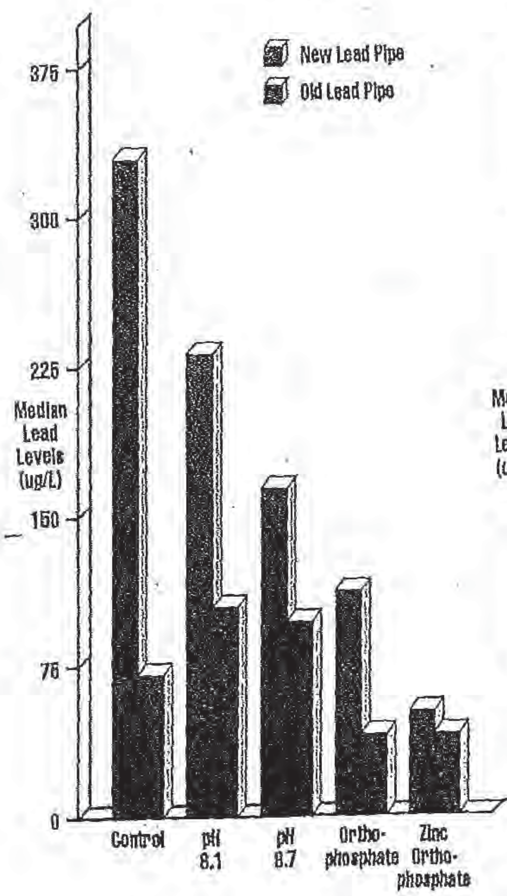


Figure ES-6
Relative Lead Levels from Soldered Copper and Brass

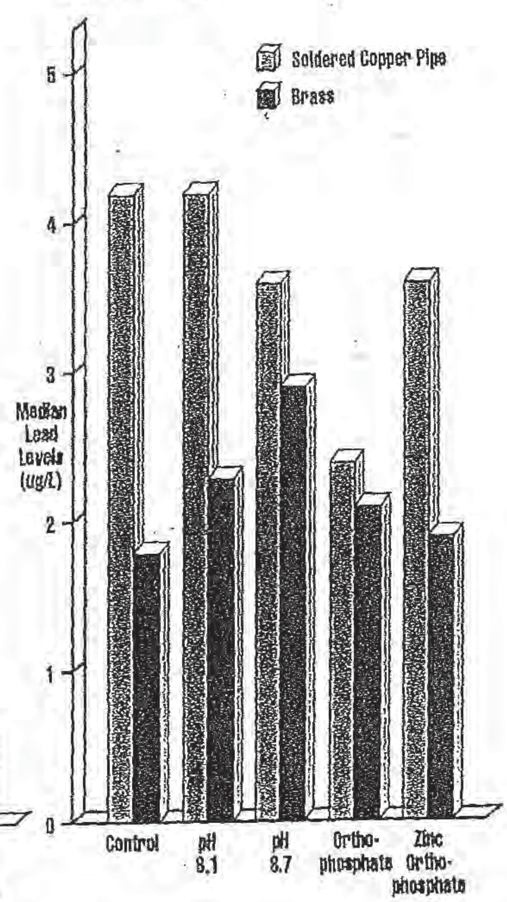
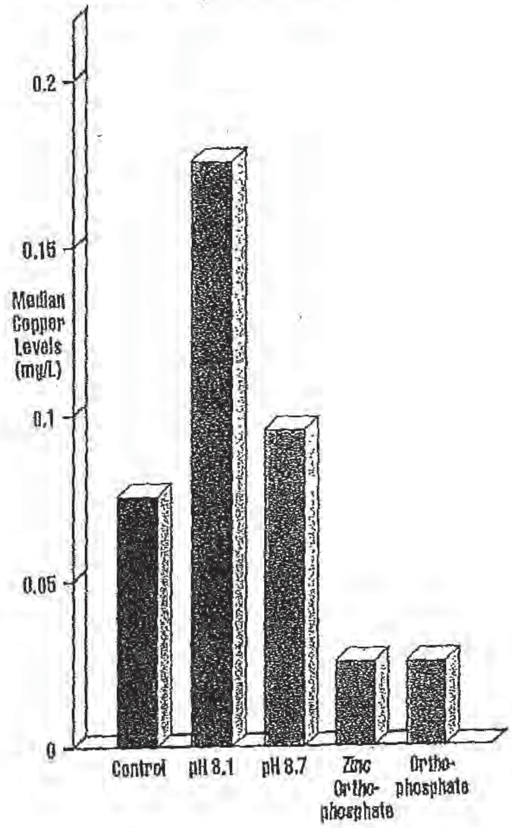


Figure ES-7
Relative Copper Levels from Copper Pipe



- DPBs were increased for the pH adjustment treatments as expected. The DBPs formed as a result of this increase, however, did not exceed EPA-proposed limits. The orthophosphate and zinc orthophosphate did not increase DBPs.
- None of the corrosion control treatments had an adverse effect on the taste and odor of the water produced.

Evaluating Corrosion Control Treatment

The four corrosion control treatments tested in the pipe loops were evaluated based on the following criteria:

- Performance for lead uptake reduction
- Feasibility of implementation within regulatory and functional constraints
- Reliability in terms of operational consistency and continuous corrosion control protection
- Cost

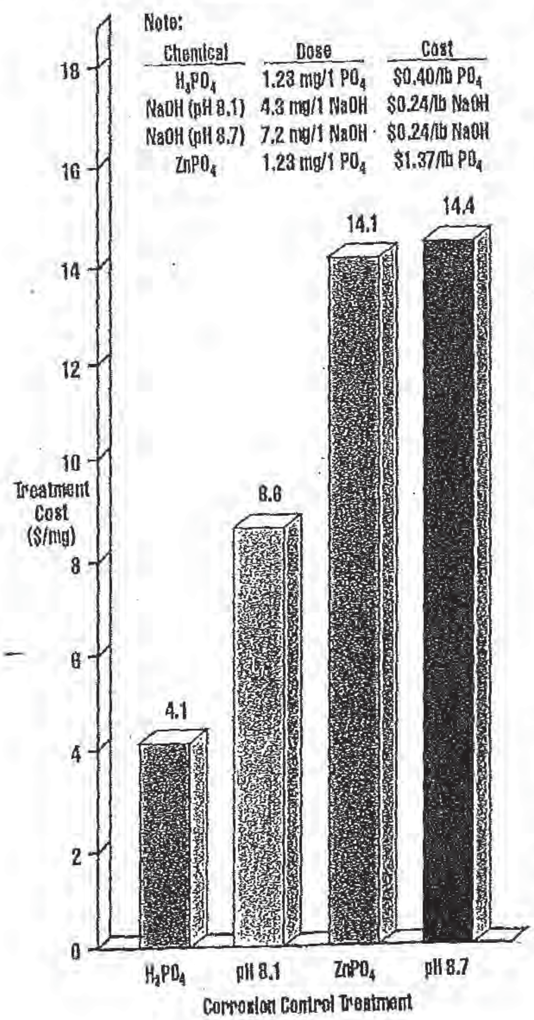
Pipe-loop data analyses indicated orthophosphate and zinc orthophosphate are most likely to yield the best results for lead reduction. pH adjustment was not as effective for lead control. Orthophosphate and zinc orthophosphate were effective at reducing copper levels.

A feasibility analysis indicated that industrial water users would be affected adversely by zinc or a higher water pH. Wastewater operations would be adversely affected by zinc and orthophosphates loadings. There were no major effects of corrosion control treatment on drinking water regulations. pH adjustment could, however, decrease disinfection effectiveness and increase DBP formation.

The reliability of zinc orthophosphate and sodium hydroxide chemicals is less than would be expected for orthophosphates. Zinc orthophosphate is a proprietary chemical with price and supply constraints. Sodium hydroxide availability and price depend on market conditions. Orthophosphate (phosphoric acid) is available as a generic chemical and is commonly used in the food and beverage industry; therefore, price and availability are more stable. From a WTP-operations standpoint, pH adjustment is less reliable because pH can change with raw water quality and treatment conditions.

The chemical cost of each treatment alternative is shown in Figure ES-8. Phosphoric acid addition is less than half the cost of pH adjustment to 8.1, the next lowest chemical cost. This represents an average cost savings of about $2,400 per day. Phosphoric acid could save the DWSD about $10 million in present worth in the next 20 years compared to the next lowest cost alternative.

Figure ES-8
Treatment Alternatives Costs



Selecting Corrosion Control Treatment

The relative ranking of alternatives for the four criteria (performance, feasibility, reliability, cost) is summarized in Figure ES-9. Values of 1 through 4 were assigned for each treatment alternative in each criteria category (1 was best; 4 worst). Because performance for lead reduction was the main criteria, it was given a weight of 2. Each of the other criteria was given a weight of 1.

Orthophosphates were ranked highest overall. Zinc orthophosphate was second, mainly because of its adverse effects on industry, wastewater plant operations, and higher costs. pH adjustment was ranked lowest because it is less effective for lead reduction, less reliable, and demonstrates more adverse effects on industry and drinking water regulatory compliance.

Orthophosphates were selected as the optimal treatment alternative for full-scale lead corrosion control.

Based on corrosion control theory, comparison with analogous water systems, and the extensive pilot plant studies, orthophosphates were selected as the optimal treatment alternative for full-scale lead corrosion control.

Figure ES-9
Alternatives Ranking
by Criteria

	Evaluation Criteria				
Treatment	Performance wt.= 2	Feasibility wt.= 1	Reliability wt.= 1	Cost wt.= 1	Weighted
Phosphoric Acid	2	1	1	1	7
Zinc Orthophosphate	1	4	2	3	11
pH 8.1	4	2	3	2	15
pH 8.7	3	3	4	4	17

Legend: 1 = Best; 4 = Worst

Phosphoric acid is the recommended form of adding orthophosphate. It is a generic chemical and can be bid competitively. It does not add sodium to the water and costs less than any other form of orthophosphate. In addition, the finished water pH is already in the optimal range for lead solubility reduction by phosphates, so pH adjustment is not required.

The recommended dose of phosphoric acid is 1.2 mg/L as P for initial passivation and a sustained dose of 0.4 mg/L as P for maintaining control of lead uptake. Values may be adjusted based on full-scale results.

Full-Scale Implementation

The LCR requires optimal corrosion control treatment installation by January 1, 1997. To meet this deadline, the implementation schedule in Figure ES-10 is proposed. The first element of implementation is to conduct full-scale demonstration testing in the distribution system served by one of the WTPs before installing chemical feed facilities in the other four plants. Operation of lead corrosion control facilities at all plants is planned for May 1996. This will provide additional time to optimize the system before lead monitoring is required in 1997.

The chemical equipment required for each WTP is summarized in Table ES-1. A schematic of a typical liquid chemical system is shown in Figure ES-11.

The cost of lead corrosion control chemicals is estimated to be about $0.87 per year per household.

The estimated capital cost for corrosion control facilities at the five WTPs is $3,740,000. The estimated cost of chemicals is $868,000 per year. The cost of lead corrosion control chemicals is estimated to be about $0.87 per year per household.

A monitoring program will be established before and after corrosion control treatment is implemented to determine performance for lead reduction and effects on other water quality parameters. If lead is reduced to below the EPA AL of 0.015 mg/L for two consecutive 6-month monitoring periods, other methods of lead reduction, such as removing lead service lines, will not be required.

If the lead AL is still exceeded after optimization and stabilization, a program for lead service line removal should be developed in addition to an ongoing public education program.

Operation of lead corrosion control facilities at all plants is planned for May 1996.

Figure ES-10
Implementation Schedule

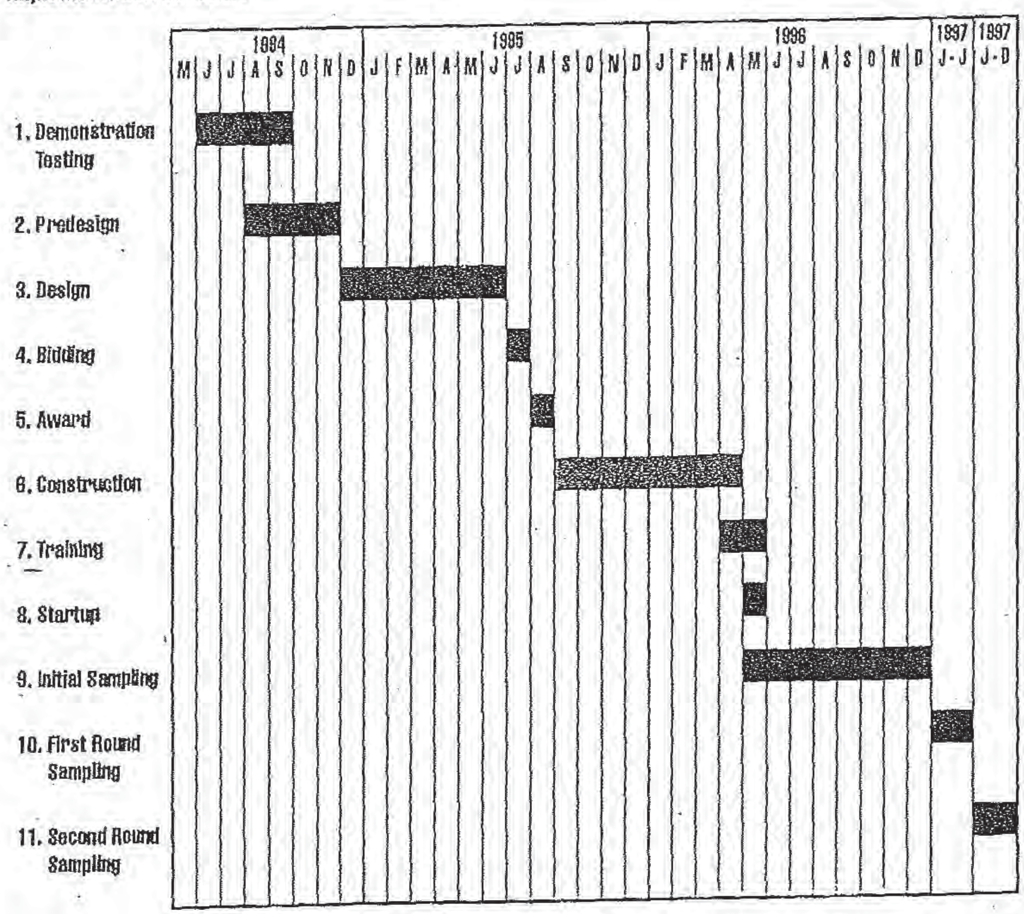
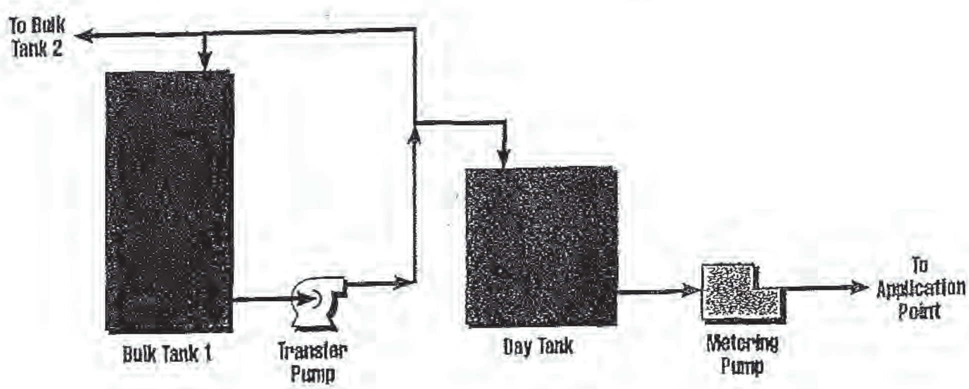


Table ES-1
Chemical Equipment Summary

	Southwest Water Plant	Water Works Park Water Plant	Northeast Water Plant	Springwells Water Plant	Lake Huron Water Plant
Number of bulk tanks	2	2	2	2	2
Bulk tank capacity, each (gal)	4,000	4,000	4,000	6,000	4,000
Number of day tanks	1	1	1	1	1
Day tank capacity (gal)	200	200	200	400	200
Number of feeders	3	3	3	3	3
Feeder capacity, each (gpd)	1 @ 200 2 @ 650	1 @ 300 2 @ 650	1 @ 250 2 @ 800	1 @ 600 2 @ 1,500	1 @ 350 2 @ 650
Number of transfer pumps	2	2	2	2	2
Transfer pump capacity each (gpm)	15	15	15	30	15

Figure ES-11
Liquid Chemical System Schematic



Introduction

Section 1
Introduction

Purpose of Study

As a result of the Safe Drinking Water Act (SDWA) Amendments of 1986, the U.S. Environmental Protection Agency (EPA) published final drinking water regulations for lead and copper in the June 7, 1991, *Federal Register*. Those regulations, known as the Lead and Copper Rule (LCR), established concentrations above which additional action is required to reduce lead and copper concentrations in the water. The action level (AL) concentrations are 0.015 mg/L for lead and 1.3 mg/L for copper at the 90th percentile. Major requirements of the LCR include:

- Monitoring program and compliance schedules based on system size
- Material survey to target corrosion sampling sites
- Source water treatment if required
- Optimal corrosion control treatment
- Public education and notification
- Lead service line replacement if required

The rule requires that all large water systems, which serve populations greater than 50,000 people, conduct corrosion control studies unless they can demonstrate that corrosion control is already optimized. Corrosion control studies must compare the effectiveness of different treatment techniques by using pipe-loop tests, metal coupon tests, or partial or full system testing. As an alternative to actual system testing, documenting of tests of an analogous system of similar raw water quality may be sufficient for comparing the effectiveness of treatment techniques. Based on the results of the corrosion control studies, large systems must submit their recommendations for optimal treatment to the state regulatory agency for approval by July 1, 1994.

The purpose of this corrosion control study is to assist the Detroit Water and Sewerage District (DWSD) to determine the best way to comply with the LCR and develop full-scale implementation approaches. This report includes pilot plant results; optimum corrosion control treatment selection criteria; full-scale implementation guidelines for optimum treatment; and the effects on water plant facilities and operation. It will serve as the basis for the DWSD's submittal to the Michigan Department of Public Health (MDPH) for optimal corrosion control treatment.

The MDPH will either approve the DWSD's recommendations or designate an alternative treatment as optimal. The MDPH will also assign values for a set of water quality parameters that constitute optimal corrosion treatment including:

- Alkalinity
- pH
- Calcium if carbonate stabilization is used
- Orthophosphate if inhibitor with a phosphate compound is used
- Silica if inhibitor with a silicate compound is used

The water system must operate within the water quality values established by the State of Michigan.

Lead and Copper Rule Overview

Introduction

The final LCR was published on June 7, 1991, in the *Federal Register* (56 FR 26460). It replaces an interim maximum contaminant level (MCL) for lead with requirements to use optimal treatment techniques for controlling lead. The LCR also established maximum contaminant level goals (MCLGs) for lead and copper based on health concerns. MCLGs are nonenforceable health-based targets.

For lead control, the LCR requires:

- Optimal corrosion control treatment
- Source water treatment (if lead exceeds established levels)
- Public education (if lead exceeds established levels)
- Lead service line replacement (if lead exceeds established levels)

For copper, the LCR requires optimal corrosion control treatment.

In addition to the treatment technique requirements, the LCR also includes:

- Monitoring requirements for lead, copper, and water quality parameters
- Analytical methods and laboratory certification requirements
- Public notification requirements
- Record keeping and reporting requirements
- Variances and exemptions
- Compliance schedules based on system size

Compliance Schedule for DWSD

The LCR compliance schedule that applies to DWSD is summarized in Table 1-1.

Health Concerns

Lead is a highly toxic metal with no known benefits to human health and is classified by the EPA as a group B2 (probable) human carcinogen. In keeping with agency policy for carcinogenic contaminants, the EPA established an MCLG for lead of zero in drinking water. The MCLG of zero was also set because there is no clear threshold for other noncarcinogenic effects, and elevated lead levels have been known to cause adverse physical and mental developmental effects in children (10 µg/dL). Lead has also been associated with increased blood pressure in adults. Elevated levels of copper can cause stomach and intestinal distress and have an adverse effect on persons with Wilson's disease.

Monitoring Requirements

The LCR requires water systems to perform extensive monitoring for lead and copper at interior residential taps. The monitoring schedule and number of samples are based on the system's population. An initial monitoring period was to be performed by large water systems during 1992 to establish further LCR compliance requirements. After applicable corrosion control treatment is installed and the state specifies the water quality parameter values for optimal corrosion control, monitoring is required. Table 1-2 summarizes the LCR monitoring schedule applicable to DWSD.

Sites selected for tap sampling are required to be "high-risk" locations–homes that contain lead solder installed since 1982, that have lead plumbing, or are served by lead service lines. The samples must be 1-liter, first-draw water from a cold water kitchen or bathroom tap that has stood motionless for at least 6 hours.

Table 1-1
Lead and Copper Rule Compliance Schedule for DWSD

Date	Action	Comments
January 1, 1992	Begin first round of system monitoring for lead and copper.	Complete.
July 1, 1993	Begin second round of monitoring for lead, copper, and water quality parameters.	Complete. Water quality parameters added because lead action level exceeded first round.
January 1, 1993	Submit monitoring results to MDPH.	Complete. Lead action level exceeded.
July 1, 1994	Submit recommended corrosion control treatment to MDPH.	Corrosion study nearing completion. Will meet deadline.
January 1, 1995	MDPH designates optimal corrosion control treatment for DWSD.	DWSD may begin installation of treatment systems.
January 1, 1997	Corrosion control systems must be complete. Begin two consecutive 6-month monitoring periods for lead, copper, and water quality parameters.	Treatment system installed at all five treatment plants.
January 1, 1998	Complete follow-up monitoring and submit results to MDPH. If lead action level still exceeded, begin lead service line replacement program.	If required, service line replacement schedule determined in conjunction with MDPH.
July 1, 1998	MDPH designates water quality limits for corrosion control. Begin two consecutive 6-month monitoring periods for lead, copper, and water quality parameters.	If lead action level still exceeded, MDPH may modify water quality limits.

Table 1-2
Lead and Copper Rule Monitoring Schedule

Monitoring Period	Dates	Parameters	Locations
Initial Monitoring	January–June 1992 and July–December 1992	• Pb, Cu • Water quality parameters[3]	• High-risk interior taps • Taps and entry points to distribution system
After Installation of Corrosion Control	January–June 1997 and July–December 1997	• Pb, Cu • Water quality parameters[4] • Water quality parameters[5]	• High-risk interior taps • Taps • Entry points to distribution system (bi-weekly)
After State Specifies Parameter Values for Optimal Corrosion Control	July–December 1998 and January–June 1999	• Pb, Cu • Water quality parameters[4] • Water quality parameters[5]	• High-risk interior taps • Taps • Entry points to distribution system (bi-weekly)
Reduced Monitoring	Once every year[1] (Once every 3 years)[2]	• Pb, Cu • Water quality parameters[4] • Water quality parameters[5]	• High-risk interior taps • Taps • Entry points to distribution system (bi-weekly)

[1] If system meets Pb and Cu AL or maintains state-specified optimal corrosion control treatment for two consecutive 6-month periods, may reduce tap sampling to once per year and collected reduced number of samples.
[2] If system meets Pb and Cu AL or maintains state-specified optimal corrosion control treatment for 3 consecutive years, may reduce tap sampling to once every 3 years and collected reduced number of samples.
[3] pH, alkalinity, ortho-P or silica, calcium, conductivity, temperature.
[4] pH, alkalinity, ortho-P or silica.
[5] pH, inhibitor dose, and inhibitor residual.

The results of LCR tap sample monitoring must be evaluated by comparing them with ALs for both lead and copper to determine the steps needed for compliance. An AL is not an MCL. It represents a level at which the utility must take additional action to reduce lead or copper exposure from water. If the concentration at the 90th percentile from the first two rounds of monitoring exceeds 0.015 mg/L for lead or 1.3 mg/L for copper, further compliance with the LCR involves optimizing corrosion control treatment techniques. Exceeding an AL during the first round of monitoring requires the utility to monitor for additional water quality parameters in the system.

Optimizing Corrosion Control

All large water systems must conduct corrosion control studies unless they can demonstrate to the state that corrosion control has already been optimized. For large systems, if the difference between the lead concentration in the source water and the 90th percentile level from the tap water monitoring for lead is less than 0.005 mg/L for two consecutive 6-month monitoring periods, the system is considered to be optimized under the LCR.

Corrosion control studies must compare the relative effectiveness of pH and alkalinity adjustment, calcium adjustment, and phosphate or silicate-based corrosion inhibitors. Demonstrating corrosion treatment optimization must be based on pipe-loop tests, metal weight loss coupon tests, partial or full-scale demonstration tests, or treatment technique documentation in analogous systems. Based on the results of the corrosion study, a plan for corrosion control optimization for a large system must be submitted to the state by July 1, 1994.

Large water systems have until January 1, 1997, to install the state-approved optimal corrosion control treatment system. Two consecutive rounds of tap monitoring must be completed to document treatment performance. The state will then designate the range of water quality limits within which the utility must operate to maintain LCR compliance.

Public Education and Public Notification

Public Education

Water systems that exceed the lead AL must deliver the EPA-approved public education program to its customers within 60 days of determination. This program informs the public of lead's effects on health, and how to reduce exposure to lead from water by tap flushing and checking for lead solder in new plumbing. Systems that exceed the lead AL must include mandatory alert language on all water bills within 60 days. Table 1-3 summarizes the LCR public education requirements.

Public Notification

The general public notification requirements of the SDWA (52 FR 41534, October 28, 1987; 54 FR 15185, April 17, 1989) also apply to the LCR. Tier 1 notification is required for treatment technique requirement violations and failure to comply with deadlines. Tier 2 notification is triggered by compliance testing and monitoring requirement failure. Violations of reporting requirements and exceedances of the copper AL do not require public notification, however, lead AL exceedances do require public education, as outlined above.

Table 1-3
Public Education Program Requirements

System	Condition	Actions Required Within 60 days	Repeat Frequency
Community Water Systems	Fails to Meet Lead Action Level*	1. Insert notices containing all of the mandatory written language and mandatory alert language in each customer's water utility bill.	Every 12 months as long as lead action level is exceeded.
		2. Submit all of the mandatory written language to major daily and weekly newspapers.	Every 12 months as long as lead action level is exceeded.
		3. Deliver pamphlets and/or brochures containing the mandatory written language on the health effects of lead and steps that can be taken in the home to reduce exposure to lead in drinking water to the following: • Public schools and/or local school boards; • City or country health department; • Women, infants, and children, and/or Head Start program(s) whenever available; • Public and private hospitals and/or clinics; • Pediatricians; • Family planning clinics; and • Local welfare agencies.	
		4. Submit the mandatory public service announcement to at least five of the radio and television stations with the largest audiences that broadcast to the community served.	Every 6 months as long as lead action level is exceeded.
	Meets the lead action level during the most recent 6-month monitoring period.	No actions required.	No action required.

* A water system failing to meet the lead action level must offer to sample the tap water of any customer who requests it. The system is not required to pay for collecting or analyzing the sample, nor is the system itself to collect and analyze the sample.

Lead Service Line Replacement

Water systems that have installed optimal corrosion control treatment and still exceed the lead AL must either begin a lead service line replacement program or demonstrate that lead service lines contribute less than 0.015 mg/L of lead to water at the tap. If the state determines that a replacement program must be implemented, the utility must replace at least 7 percent annually of the lead service lines in its control to complete removal within 15 years from the start of replacement.

Recordkeeping and Reporting

Water systems must retain original records of all sampling data and analyses, reports, surveys, evaluations, schedules, state determinations, and other information required by the LCR for at least 12 years. Separate reports are required for each of the following:

- Tap water monitoring for lead, copper, and water quality parameters
- Source water monitoring
- Corrosion control treatment
- Lead service line replacement
- Public education program

Scope of Work

To accomplish the work necessary to comply with the LCR requirements, the DWSD entered into an agreement with Tucker, Young, Jackson, Tull, Inc., (TYJT) in association with CH2M HILL, INC., and Economic and Engineering Services, Inc. The scope of work included three phases generally described as follows:

- Phase I–Corrosion Control Optimization Study
  - Conduct a desktop analysis of viable corrosion control techniques applicable to DWSD
  - Design and construct pilot testing facilities
  - Operate pilot plant for 1 year
  - Prepare a final Corrosion Control Optimization Report for submission to MDPH
- Phase II–Design Corrosion Control Facilities
  - Design full-scale corrosion control facilities
  - Provide bidding period services
- Phase III–Construct Corrosion Control Facilities
  - Provide services during construction
  - Provide startup services, training, and the operations and maintenance (O&M) manual

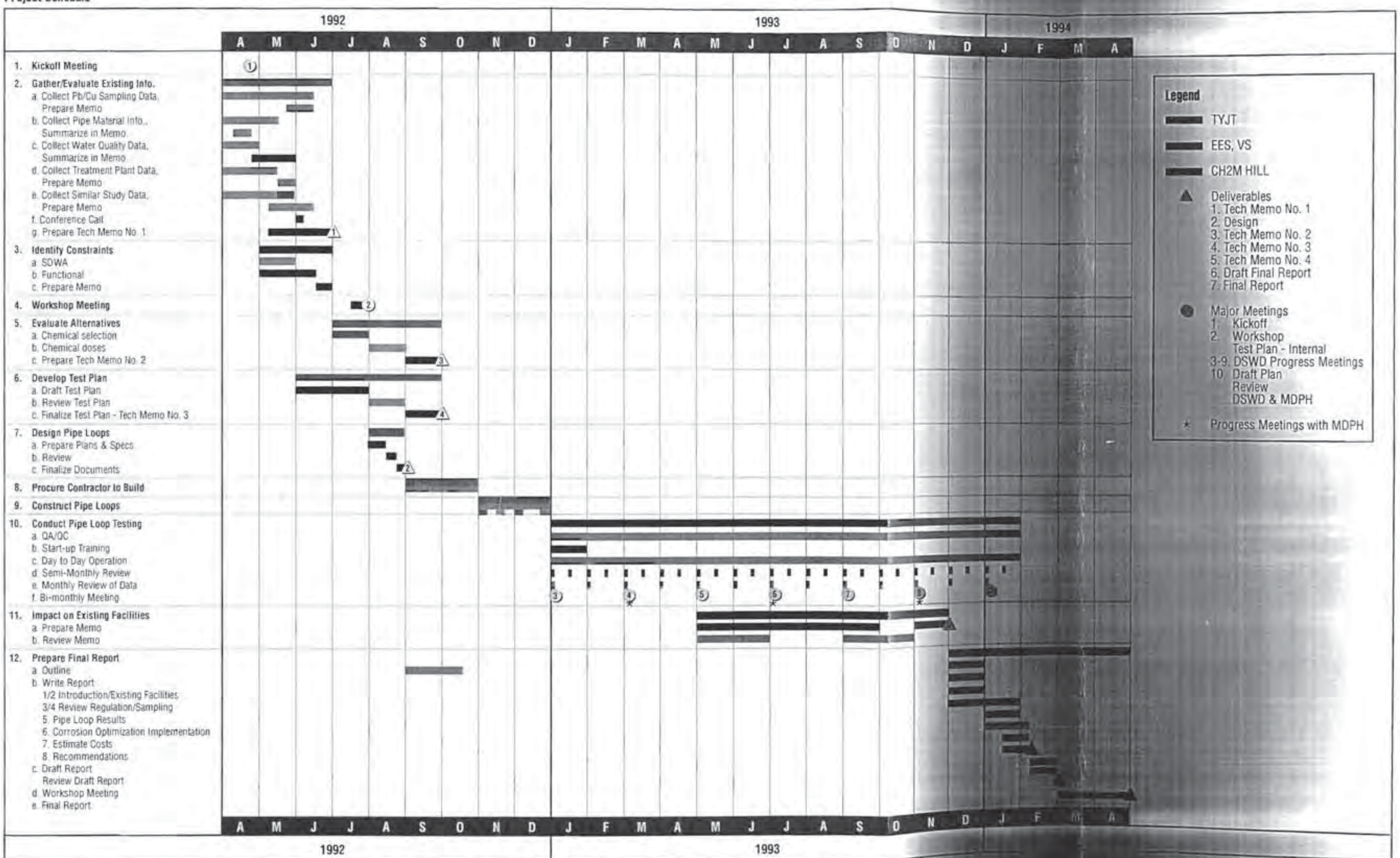
This report presents the results of the Phase I study and makes recommendations for optimal corrosion control.

Approach

The DWSD *Corrosion Control Optimization Study* (Phase I of the CS-1171 Contract) began in March 1992. The project schedule is presented in Figure 1-1. The Corrosion Control Optimization Study consisted of the following tasks:

Task 1–Project Kickoff Meeting
Task 2–Gather/Evaluate Existing Information
Task 3–Identify Constraints
Task 4–Evaluate Alternatives
Task 5–Develop Piloting Test Plan
Task 6–Design Pipe Loops
Task 7–Procure Contractor
Task 8–Construct Pipe Loops
Task 9–Conduct Pipe Loop Testing
Task 10–Evaluate Effects on Existing Facilities
Task 11–Prepare Final Report

Figure 1-1
Project Schedule



An important aspect of the project approach has been the series of workshops with DWSD, MDPH, and affected communities. The workshops' purpose was to issue project status reports, seek input, and build consensus. During the course of the project, five workshops were held as follows:

- Workshop 1 on July 29–30, 1992–Review Existing Information
- Workshop 2 on May 27, 1993–Evaluate Alternatives/Status Report
- Workshop 3 on September 9–10, 1993–Present Preliminary Pipe Loop Testing Results
- Workshop 4 on December 16, 1993–Cryptosporidium/Regulatory Update
- Workshop 5 on March 29, 1994–Present Final Report

Before each workshop and as the project progressed, various technical memorandums were issued to document progress and decisions made to date. Technical memorandums were issued as shown on the project schedule.

Another important part of the project approach has been MDPH participation in reviewing intermediate project deliverables and providing input as the project progressed. This was invaluable in building consensus and identifying the optimal corrosion control technique for DWSD.

Water System Description

General

The DWSD supplies water to nearly 4 million customers in metropolitan Detroit. Water is distributed to 119 communities. A list of the communities supplied by DWSD is presented in Table 1-4. The area served by DWSD is shown in Figure 1-2.

Water Supply

The DWSD has three raw water intake systems. Two are located in the Detroit River, one at the northern end of Belle Isle, and one downriver off the west side of Fighting Island. The third intake structure is located at Lakeport on the southern end of Lake Huron.

Water Treatment

The DWSD manages five WTPs including:

Plant	Year Built	Present Reliable Capacity* (mgd)
Water Works Park	1910-1935	320
Springwells **	1929	540
Northeast	1955	300
Southwest	1964	210
Lake Huron	1974	240

* *Defined as the production capacity which can be achieved on a sustained basis.*
** *With raw water booster pumps at Water Works Park Plant running.*

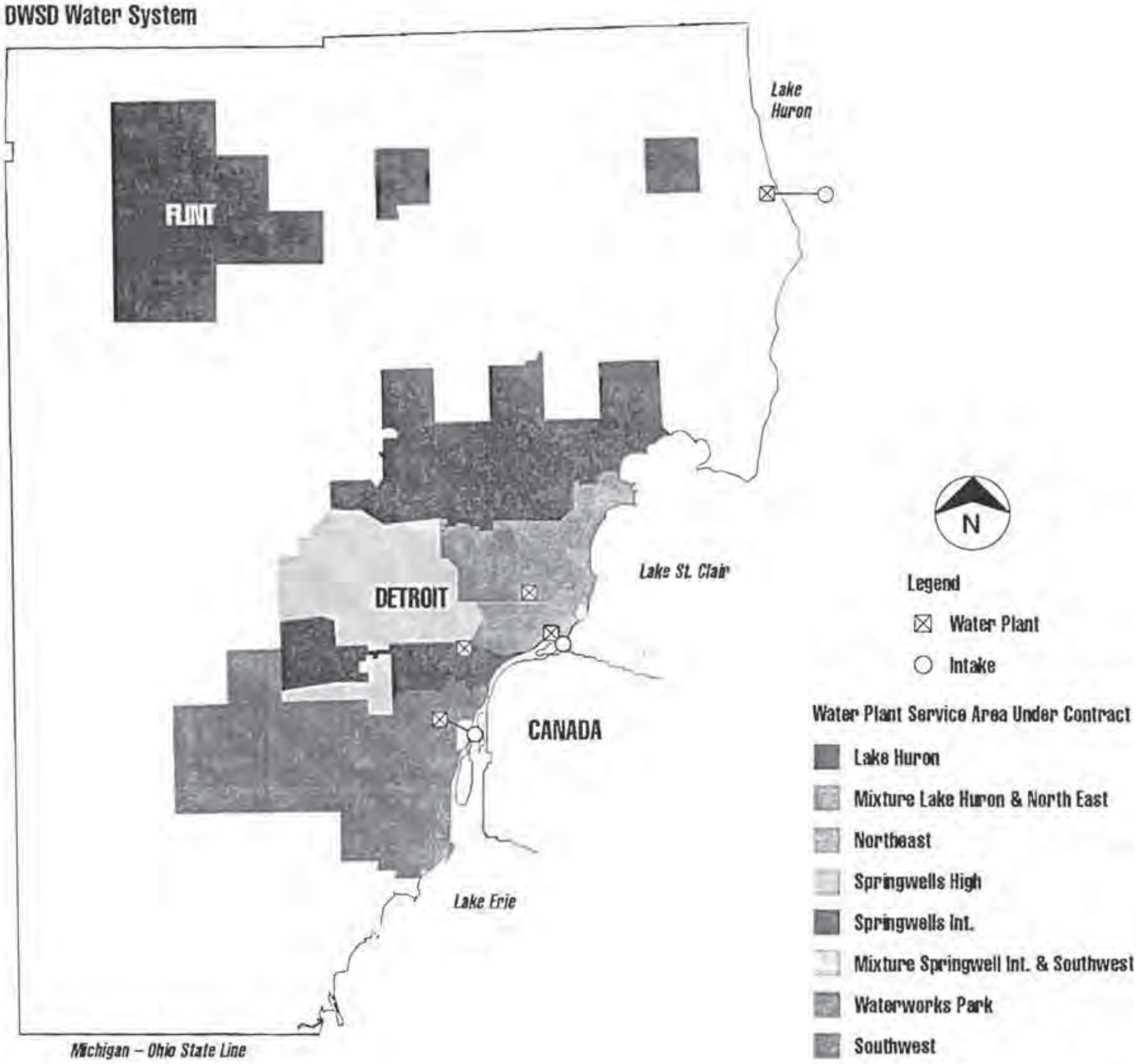
The WTPs' locations are also shown in Figure 1-2. The present reliable capacity of the DWSD WTPs is 1,610 mgd. Currently, the DWSD is supplying an average of 640 mgd. Four of the plants, including Water Works Park, Springwells, Northeast, and Southwest, are located within the metropolitan area of Detroit. The Lake Huron WTP is located 50 miles north of Detroit. All five facilities use conventional treatment technology. Treatment consists of alum coagulation using mechanical or hydraulic rapid mix; mechanical or hydraulic flocculation; sedimentation; dual media filtration and chlorine disinfection.

Each plant uses prechlorination before flocculation and sedimentation and post-chlorination after filtration. Fluoride is also added to each WTP's finished water. The plants use powdered

Table 1-4
Communities Served by DWSD

Allen Park	Clayton Twp.	Garden City	Lincoln Park	Plymouth Twp.	St. Clair Shores
Almont	Clinton Twp.	Genesee County	Livonia	Plymouth	Sumpter Twp
Ash Twp.	Clio	Gibraltar	Macomb County	Pontiac	Superior Twp
Auburn Hills	Commerce Twp.	Grand Lapeer CUA	Madison Heights	Redford Twp	Swartz Creek
Augusta Twp.	Davison Twp.	Gross Ile Twp.	Mayfield Twp.	River Rouge	Taylor
Belleville	Dearborn	Grosse Pointe Park	Melvindale	Riverview	Trenton
Berkeley	Dearborn Heights	Grosse Pointe Shores	Montrose	Rochester Hills	Troy
Berlin Twp.	Detroit	Grosse Pointe Woods	Mount Clemens	Rockwood	Utica
Beverly Hills	Eastpoint	Hamtramck	Mt. Morris	Romeo	Van Buren Twp
Bingham Farms	Ecorse	Harper Woods	Mt. Morris Twp.	Romulus	Vienna Twp
Birmingham	Farmington Hills	Harrison Twp.	Mundy Twp	Roseville	Walled Lake
Bloomfield Twp.	Farmington	Hazel Park	New Haven	Royal Oak Twp.	Warren
Bloomfield Hills	Ferndale	Huntington Woods	Northville	Royal Oak City	Washington Twp
Brownstone Twp	Flat Rock	Huron Twp.	Northville Twp.	S. Oak Co. W.A.	Wayne
Burton	Flint	Imlay City	Novi	Shelby Twp.	West Bloomfield Twp
Canton	Flint Twp.	Inkster	Oak Park	South Rockwood	Westland
Carleton	Flushing	Keego Harbor	Oak Co. Drain Comm.	Southfield	Woodhaven
Centerline	Flushing Twp.	Lapeer	Orion Twp	Southgate	Ypsilanti Comm. U.A.
Chesterfield Twp.	Fraser	Lathrup Village	Pittsfield	Sterling Heights	Ypsilanti Twp.
Clawson	Gaines Twp.	Lenox	Pleasant Ridge	St. Clair Co.	

Figure 1-2
DWSD Water System



activated carbon (PAC) to combat seasonal taste and odor problems. Chemical addition is operated manually and adjusted based on raw water quality and finished distribution system water quality.

Finished water clearwell storage is provided at each plant. High-lift pumps pump the treated water into the transmission system.

Transmission and Distribution System

On the average, 640 mgd is conveyed from the five WTPs through over 11,000 miles of watermains providing 363 million gallons of system storage to DWSD customers. In addition to the high-service pump stations, there are 20 booster pump stations to supply water to three pressure zones.

The different pressure zones are interconnected to enhance continuity of service and meet the flow and pressure demands occurring during peak load periods or emergencies. All pumping operations are coordinated from the Systems Control Center (SCC). The SCC continuously monitors about 60 pressure points throughout the system.

EXHIBIT 10

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF:

WG-15J

June 24, 2015

MEMORANDUM

SUBJECT: High Lead Levels in Flint, Michigan – Interim Report

FROM: Miguel A. Del Toral
Regulations Manager, Ground Water and Drinking Water Branch

TO: Thomas Poy
Chief, Ground Water and Drinking Water Branch

The purpose of this interim report is to summarize the available information regarding activities conducted to date in response to high lead levels in drinking water reported by a resident in the City of Flint, Michigan. The final report will be submitted once additional analyses have been completed on pipe and water samples.

Following a change in the water source, the City of Flint has experienced a number of water quality issues resulting in violations of National Primary Drinking Water Regulations (NPDWR) including acute and non-acute Coliform Maximum Contaminant Level (MCL) violations and Total Trihalomethanes (TTHM) MCL violations as follows:

Acute Coliform MCL violation in August 2014
Monthly Coliform MCL violation in August 2014
Monthly Coliform MCL violation in September 2014
Average TTHM MCL violation in December 2014
Average TTHM MCL violation in June 2015

In addition, as of April 30, 2014, when the City of Flint switched from purchasing finished water from the City of Detroit to using the Flint River as their new water source, the City of Flint is no longer providing corrosion control treatment for lead and copper.

A major concern from a public health standpoint is the absence of corrosion control treatment in the City of Flint for mitigating lead and copper levels in the drinking water. Recent drinking water sample results indicate the presence of high lead results in the drinking water, which is to be expected in a public water system that is not providing corrosion control treatment. The lack of any mitigating treatment for lead is of serious concern for residents that live in homes with lead service lines or partial lead service lines, which are common throughout the City of Flint.

In addition, following the switch to using the Flint River, the City of Flint began adding ferric chloride, a coagulant used to improve the removal of organic matter, as part of the strategy to reduce the TTHM levels. Studies have shown that an increase in the chloride-to-sulfate mass ratio in the water can adversely affect lead levels by increasing the galvanic corrosion of lead in the plumbing network.

Prior to April 30, 2014, the City of Flint purchased finished water from the City of Detroit which contained orthophosphate, a treatment chemical used to control lead and copper levels in the drinking water. When the City of Flint switched to the Flint River as their water source on April 30, 2014, the orthophosphate treatment for lead and copper control was not continued. In effect, the City of Flint stopped providing treatment used to mitigate lead and copper levels in the water. In accordance with the Lead and Copper Rule (LCR), all large systems (serving greater than 50,000 persons) are required to install and maintain corrosion control treatment for lead and copper. In the absence of any corrosion control treatment, lead levels in drinking water can be expected to increase.

The lack of mitigating treatment is especially concerning as the high lead levels will likely not be reflected in the City of Flint's compliance samples due to the sampling procedures used by the City of Flint for collecting compliance samples. The instructions from the City of Flint to residents direct the residents to 'pre-flush' the taps prior to collecting the compliance samples. A copy of the instructions provided by the City of Flint to residents will be included in the final report.

The practice of pre-flushing before collecting compliance samples has been shown to result in the minimization of lead capture and significant underestimation of lead levels in the drinking water. Although this practice is not specifically prohibited by the LCR, it negates the intent of the rule to collect compliance samples under 'worst-case' conditions, which is necessary for statistical validity given the small number of samples collected for lead and copper under the LCR. This is a serious concern as the compliance sampling results which are reported by the City of Flint to residents could provide a false sense of security to the residents of Flint regarding lead levels in the water and may result in residents not taking necessary precautions to protect their families from lead in the drinking water. Our concern regarding the inclusion of 'pre-flushing' in sampling instructions used by public water systems in Michigan has been raised with the Michigan Department of Environmental Quality (MDEQ). The MDEQ has indicated that this practice is not prohibited by the LCR and continues to retain the 'pre-flushing' recommendation in their lead compliance sampling guidance to public water systems in Michigan. A copy of the MDEQ guidance will be included in the final report.

In the case of the Flint resident that contacted U.S. EPA (Ms. Lee-Anne Walters), the initial results from drinking water samples collected by the City of Flint in her home for lead were 104 ug/L and 397 ug/L. The level of iron in the water also exceeded the capability of the measurement (>3.3 mg/L). The lead results were especially alarming given that the samples were collected using the sampling procedures described above, which minimize the capture of lead. When contacted by U.S. EPA Region 5, the MDEQ indicated that the lead was coming from the Walters' plumbing. Ms. Walters had previously indicated that all of the plumbing in the home was plastic.

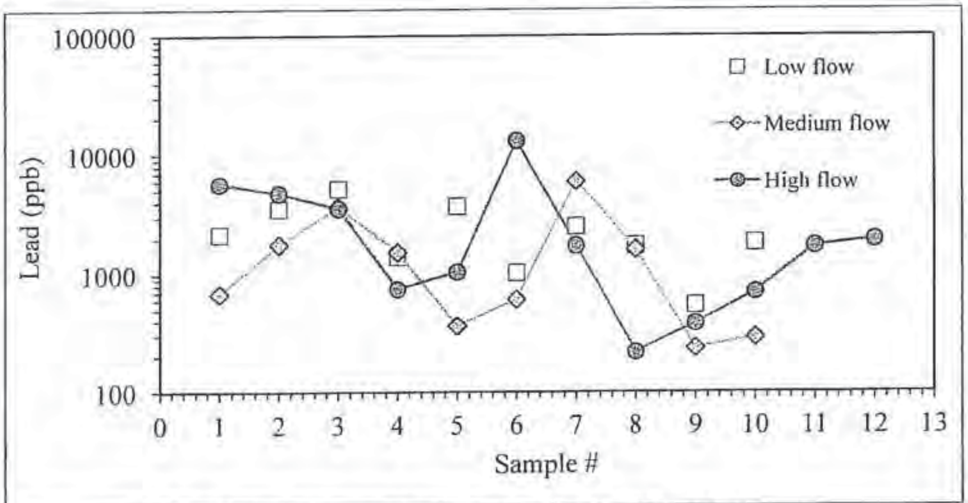
Following the confirmation of the initial high lead results, U.S. EPA Region 5 conducted two visits to the Walters' home on April 27, 2015 and May 6, 2015. Based on an inspection of the plumbing and subsequent sampling conducted at the Walters' residence, it was determined that except for a few minor metallic connectors, all interior plumbing, including the pipes, valves and connectors are made of plastic certified by the National Sanitation Foundation (NSF) for use in drinking water applications. Subsequent sampling showed that the faucets in the home appear to be compliant with the new lead-free requirements and are also not the source for the high lead levels. Our inspection of the interior plumbing and analysis of follow-up sampling results demonstrate that the home plumbing network is not the source of the high lead levels found at the Walters' residence. The photographs and all sampling results will be included in the final report.

Based on the U.S. EPA inspection and documentation of the plastic plumbing at the Walters' residence, it was suspected that the high lead was being introduced into the Walters' home plumbing from outside the home, likely from a lead service line. Three portions of the service line were extracted during a subsequent trip on May 6, 2015 and sent for analysis, when the Walters' service line was replaced. Analyses performed to date indicate that a portion of the service line is made of galvanized iron pipe. Inspection of the remaining portion from the water main to the external shut-off valve confirmed that the portion from the water main to the external shut-off valve is a lead service line.

Ms. Walters has also provided U.S. EPA with medical reports on her child's blood lead testing indicating that the child had a low blood lead level (2 ug/dL) prior to the source water switch and an elevated blood lead level following the switch (6.5 ug/dL). Redacted copies of these reports will also be included in the final report.

Subsequent to the discovery of high lead levels in the Walters' drinking water, the water to the Walters' home was shut off on April 3, 2015. The water was briefly turned back on to collect additional samples on April 28, 2015. Since the water had stagnated for an extended period of time, the kitchen tap was flushed for 25 minutes the night before collecting the samples. Three sets of samples were collected at different flow rates (10 at low flow, 10 at medium flow and 10 at high flow).

The drinking water samples collected from the Walters' residence on April 28, 2015 contained extremely high lead levels, ranging in value from 200 ug/L to 13,200 ug/L (see below).



Sample results and graph are provided courtesy of Virginia Tech

Additional sample results from resident-requested samples have also shown lead levels in excess of the lead action level. As with the samples collected by the City of Flint for compliance, the resident-requested samples are also being collected using the 'pre-flushing', so the lead levels captured in these samples likely do not represent the worst-case lead levels in the water and the actual lead levels at these homes may be much higher.

Pending completion of the final report, my interim recommendations are as follows:

1. The U.S. EPA should follow up with the MDEQ and the City of Flint on the recommendation made by U.S. EPA to MDEQ on June 10, 2015 to offer the City of Flint technical assistance on managing the different water quality issues in Flint, including lead in the drinking water. Although there have been two written assessments regarding water quality and operational issues in Flint at the time of this report, they do not address lead in drinking water. The first is an Operational Evaluation Report (OER) produced in November 2014 by Lockwood, Andrews and Newnam, Inc. to assess the factors contributing to high Total Trihalomethane (TTHM) levels in Flint following the source change. The focus of this report is to identify potential causes and remedial actions for lowering TTHM levels. The second report (Water Quality Report) produced by Veolia for the City of Flint on March 12, 2015, is an assessment of Flint's water quality and operations which provides advice to the City of Flint primarily focused on TTHM control and other operational issues. Both reports were written prior to the recent discovery of high lead results in Flint drinking water. As such, the reports do not take into account the potential effects on lead levels in drinking water.

As previously mentioned, the City of Flint currently has no mitigating treatment for lead and is also planning another source water change in the near future. U.S. EPA's Office of Research and Development in Cincinnati has extensive experience in corrosion and corrosion control treatment and distribution system issues and would be a valuable addition to the drinking water advisory group for the City of Flint. Copies of the qualifications and experience for Michael Schock and Darren Lytle have been forwarded to MDEQ.

2. U.S. EPA should review the compliance status of the City of Flint with respect to whether the system is in violation of the LCR requirement to install and maintain optimal corrosion control and whether the MDEQ is properly implementing the LCR provisions regarding optimal corrosion control treatment requirements for large systems. Pursuant to 40 CFR Section 141.82(i), the EPA Regional Administrator may review treatment determinations made by a State and issue federal treatment determinations consistent with the requirements of the LCR where the Regional Administrator finds: (1) A state has failed to issue a treatment determination by the applicable deadlines; (2) A State has abused its discretion in a substantial number of cases or in cases affecting a substantial population; or (3) The technical aspects of a State's determination would be indefensible in an expected Federal enforcement action taken against a system.

3. The U.S. EPA should review whether relevant resident-requested samples are being included by the City of Flint in calculating the 90th percentile compliance value for lead. Recent drinking water tests conducted at homes in Flint for lead that are not part of the compliance sampling pool have revealed high lead levels in the drinking water. The U.S. EPA memorandum signed on December 23, 2004 provides clarification on compliance determinations and states that customer-requested samples are to be included in the 90th percentile lead compliance calculation where the sampling is conducted during the monitoring period from sites and sampling procedures meeting the LCR criteria. Given the prevalence of lead service lines in the City of Flint, should these sample results be from homes with lead service lines, the sample results would be considered compliance samples under the LCR.

Also attached is a timeline of events for Flint, Michigan. Should you have any questions regarding the information or recommendations provided, please let me know.

cc: Liane Shekter-Smith (MDEQ)
Pat Cook (MDEQ)
Stephen Busch (MDEQ)
Michael Prysby (MDEQ)
Marc Edwards (Virginia Tech)
Michael Schock, EPA-ORD
Darren Lytle, EPA-ORD