Action Plan

To

Reduce the Occurrence of Lead

Leaching from Service Lines, Solder, or Fixtures

Into Tap Water

In the District of Columbia

And Arlington County and Falls Church, Virginia

Prepared by:

United States Environmental Protection Agency, Region 3
Washington Aqueduct, US Army Corps of Engineers
District of Columbia Water and Sewer Authority

With the cooperation of:

District of Columbia Department of Health
Arlington County Department of Public Works
Falls Church Department of Environmental Services

Assisted by:

CH2M Hill
Baker-Killam Joint Venture
HDR Engineering
US EPA Office of Research and Development

Introduction

In July 2002, the District of Columbia Water and Sewer Authority's (WASA) routine tap samples for lead exceeded the action level of 15 parts per billion (ppb). The 90^{th} percentile level of lead went from 8 parts ppb the monitoring period before, to 75 ppb, with more than half the samples exceeding the action level. This milestone required that: 1) WASA collect more routine tap samples, more often; 2) WASA implement a public education program; and 3) WASA begin replacing lead service lines at a minimum rate of 7% of their inventory each year. The following monitoring period, ending June 30, 2003, WASA again exceeded the action level (40 ppb), requiring continuation of the public education program and lead service line replacement program as well as continue with the full routine tap monitoring.). With two monitoring periods of exceeding the action level, it became apparent that the elevated levels of lead were not a transient event and that the Washington Aqueduct and WASA would need to perform another corrosion control treatment study to determine a revised optimal corrosion control treatment for reducing lead levels in customer's tap samples.

WASA and EPA recognized the need to research why tap water lead levels increased suddenly. In the spring of 2003, EPA began the process to acquire an independent corrosion expert to help answer this question. The services of Dr. Marc Edwards of Virginia Tech were acquired in May of 2003. Dr. Edwards performed his investigations during the spring, summer and fall of 2003. He presented his written report to EPA Region III in October 2003 and presented his findings to EPA, WASA and the Washington Aqueduct in early November 2003.

WASA then developed a research strategy based on the recommendations of Dr. Edwards. This strategy was presented to the Washington Aqueduct, their Virginia wholesale customers and EPA in January 2004. WASA had begun implementing this strategy prior to the January 2004 presentation.

Again, WASA's routine tap sampling results for the six-month period ending December 2003 exceeded the lead action level (63 ppb). This necessitated the continuation of the public education and lead service line replacement programs. Both of these programs must continue until the 90^{th} percentile lead levels are 15 ppb or below for two consecutive monitoring periods (12 months).

This Action Plan lays out the activities and targeted dates for their implementation for reducing lead levels in tap water of the District of Columbia and Arlington County and Falls Church, Virginia. This Plan may be revised or adjusted based on input from the Independent Peer Review Team being assembled by EPA's Office of Ground Water and Drinking Water. Revisions to this plan may also be made based on the feedback from studies carried out as outlined below.

Overview of the Technical Expert Working Group

The Technical Expert Working Group (TEWG) was formed to facilitate and expedite on-going research conducted by both WASA and the Washington Aqueduct (WA) of the Army Corps of Engineers as well as research already planned but not yet carried out. The U.S. Environmental Protection Agency Region III (EPA), WASA and WA recognized that an overarching planning and coordination effort was needed to help ensure that all the necessary research was conducted, to ensure no redundant efforts took place and to move the work along as quickly as possible.

EPA, WASA and WA first gathered on a teleconference on February 5, 2004 to discuss research plans in place in both WASA and the Aqueduct. Another important purpose of the call was to develop a listing of any further work that needed to take place to find a treatment solution for re-optimizing the Aqueduct's optimal corrosion control treatment (OCCT). It was decided on that teleconference that the group should meet face to face to outline an overall strategy to this research effort. Staff and contractors for WASA and the Aqueduct, as well as EPA staff members from the Mid-Atlantic Regional Office, EPA's Office of Research and Development in Cincinnati, OH, and EPA's Office of Ground Water and Drinking Water gathered on the following Monday, February 9, 2004. The Group agreed to the strategy outline that formed the basis for this document as well as the Group's structure.

Organization of the Technical Expert Working Group

The TEWG consists of an overall Advisory team and three Technical Research Project Teams. Members of the Teams have representatives from all three entities. New members will be added to the Group as the need to add additional expertise is determined. The Technical Research Project Teams report to the Technical Advisory Team through a team leader. The Technical Advisory Team will provide for overall coordination of the Working Group and will be responsible for major decision points in the research process.

TEWG Members are:

EPA Region III

Rick Rogers, Chief, Drinking Water Branch

George Rizzo, Program Manger, District of Columbia Direct Implementation Program

Outside sub-contractor: Steven Reiber, Ph.D., and National Director for Water Research, HDR, INC., corrosion specialist

Outside sub-contractor: Gregory V. Korshin, Ph.D., Associate Professor, Environmental Eng. & Science, University of Washington; corrosion expert

Outside sub-contractor: Anne Camper, Montana State University; biofilm/disinfection/microbial corrosion expert (added early March)

EPA Office of Ground Water and Drinking Water
Jeffrey Kempic, Treatment Technology and Cost Team Leader, Standards and Risk Management Division

EPA Office of Research and Development
Michael Schock, National Risk Management Research Laboratory, Water Supply and Water Resources Division, Treatment Technology Evaluation Branch; corrosion expert

Centers for Disease Control and Prevention
Barry Brooks, Lead Poisoning Prevention Program, D.C. and Virginia Project Officer

District of Columbia Department of Health
James Collier, Director, Water Quality Division, Bureau of Environmental Quality
Gregory Hope, Water Quality Division

Washington Aqueduct
Tom Jacobus, P.E., General Manager
Lloyd Stowe, P.E., Chief, Plant Operations Branch
Patty Gamby, Chief, Waterworks, Environmental, and Electrical Engineering Section
Elizabeth Turner, Chief, Washington Aqueduct Laboratory
Miranda Brown, Special Assistant for Water Quality
Outside Contractors, CH2M Hill
Outside sub-contractor: Vern Snoeyink, Ph.D., and Professor of Environmental Engineering, University of Illinois; corrosion expert

D.C. WASA
Michael Marcotte, Deputy General Manager and Chief Engineer
Kofi Boateng, Director, Department of Water Services
Rich Giani, Water Quality Manager
Outside Contractors: Baker-Killam Joint Venture

Arlington County, Virginia
David Hundelt, Department of Public Works, Water, Sewer, and Streets Division

Falls Church, Virginia
Robert Etris, Department of Environmental Services, Public Utilities Division

Technical Advisory Team: consists of Thomas Jacobus, P.E., General Manager, Washington Aqueduct; Michael Marcotte, P.E., Deputy General Manager, DCWASA, Rick Rogers, Chief, Drinking Water Branch, U.S. EPA Region III, James Collier, Director, Water Quality Division, DC Department of Health

Technical Research Project Teams:

Production Treatment Operations Team led by Washington Aqueduct
Distribution System Operations Team led by DCWASA

Communications Team led by U.S. EPA Region III

Mission and Priorities

The Group's mission is to develop a plan to reduce the corrosivity of treated drinking water in the District of Columbia to reduce consumers' overall lead exposure, through tap water to allowable levels. The mission of the TEWG is to determine, through bench-top, pilot scale and literature research, a revised optimal corrosion control treatment process for the Aqueduct. This re-optimized treatment will result in drastically reduced lead levels in the customer's tap water and WASA meeting EPA's lead action level. Seven main priorities of the Group are detailed below.

1. Communicate actions and progress to the community on a regular basis.

2. Choose a revised optimal corrosion control treatment (OCCT) based on desktop analysis and verified through partial system application and DC WASA and WA pipe loop studies.

3. Consider demonstration of a revised OCCT in a partial system test.

4. Leave open the possibility of an immediate full system implementation.

5. EPA interim and final approval of selected re-optimization of corrosion control treatment.

6. Execute full system operations.

7. Use on-going pipe loop studies to refine chemistry and to determine the cause of elevated lead level.

The Research Process and Reaching a Treatment Solution Decision

The research strategy is designed to reach a treatment decision that will reduce the corrosivity of the water through a three-part plan. The three parts are:

1) Conducting a desktop analysis of all potential treatment options and make a recommendation for a revised corrosion control treatment process to the Technical Expert Working Group;
2) Conducting bench scale and pipe loops studies that will verify chemical dosage for the treatment options available and for the option selected during the desktop analysis; and
3) Communicate the strategy, the progress, the expected interim water quality effects and final outcomes to the public, the press, and government and community leaders.

The Aqueduct and WASA are responsible for developing a recommendation for a revised OCCT. It is EPA's responsibility to review and approve the revised OCCT based on input from experts from all parties. This will include feedback from an independent review panel selected by EPA's Office of Ground Water and Drinking Water in Washington, D.C. EPA's and its contractor's involvement in the planning and implementation of this corrosion control treatment study is limited to coordination and advisory roles. Being involved from the very beginning, however, will enable a very rapid review and approval/disapproval decision on the treatment proposed.

The Technical Expert Working Group does not expect that any treatment selected and implemented will immediately reduce lead levels in the tap water. The Working Group expects lead levels to decrease over the course of implementing the revised treatment for at least several months. The Working Group also points out that, depending on the type of treatment selected, temporary changes in the aesthetic quality of the water may occur. These may be: a temporary release of rust from the water mains (red water) in some areas; an increase in calcium (lime) deposition in the water mains and in customers plumbing (if pH is adjusted higher with lime dosage); and an increase in indicator bacteria organisms, called total coliform bacteria. Some bacteria in the total coliform group are commonly among the population of harmless organisms that inhabit the rusty areas of water mains. When the rust is released, their presence may be detected in more samples than usual. The Washington Aqueduct and the Water and Sewer Authority will be taking every step possible to minimize the potential for these changes. One step will be performing an aggressive water main flushing program to help remove rust from the lines prior to applying the revised corrosion control treatment. They will monitor the water very closely during the partial treatment application and during the application of the revised treatment across the entire system distribution system.

What Consumers Should Do Until Lead Levels Decrease

Until the revised treatment scheme is in place and lead levels in tap water are reduced, the Technical Expert Working Group highly recommends that all consumers follow the tap flushing recommendations provided by EPA, WASA and the District of Columbia Department of Health (DCDOH) and DCDOH's special advisory for children, nursing mothers and pregnant women who live in homes with lead service lines. These are repeated on the following page for clarity:

Consumer advisory

Steps you should take today to reduce potential exposure to lead in drinking water:

All consumers:

• Cold water should be used for drinking or cooking, as hot water will contain higher levels of lead. Cold water should be heated on the stove for making hot beverages or cooking. Boiling your water will not remove lead!

• Flush water lines that have not been used for more than six hours by running the cold water ("flush") for 60 seconds prior to using the water from a faucet for drinking or cooking.

•Periodically, remove and clean the strainer/aerator device on your faucet to remove debris.

In addition, if you believe that you have a lead service line:

• The District of Columbia Department of Health (DC DOH) recommends that children under 6 years old and women who are pregnant or breast feeding should not drink unfiltered tap water until the concerns regarding the lead levels in the water have been resolved. DC DOH advises that unfiltered tap water should not be used for preparing infant formula or concentrated juices. In addition, DC DOH recommends that all pregnant women and children under 6 years old have their blood lead level tested. For more information on blood lead level screening, contact DC DOH at (202) 671-0733.

• Draw water for drinking or cooking after another high water use activity such as bathing or washing your clothes so that a total of at least 10 minutes of flushing has occurred. (The large amount of water used will flush significant amounts of water from your home's pipes.)
and
• Flush your kitchen tap for 60 seconds and then collect drinking water in clean containers and store in the refrigerator.

If you still have concerns:

• Have your water tested by a certified laboratory or contact DC WASA

Special recommendations for homes with children, pregnant women, and nursing mothers

Children and pregnant women are most at risk of adverse health effects from lead in drinking water. In homes with lead service lines, the District of Columbia Department of Health (DC DOH) recommends that children under 6 years old and women who are pregnant or breast feeding should not drink unfiltered tap water, nor should unfiltered water be used for preparation of infant formula or concentrated juices, until the concerns regarding the lead levels in the water have been resolved. DC DOH also recommends that all pregnant women and children under 6 years old have their blood lead level tested.

Three Part Research Strategy

Production Treatment Operations Team

The Production Treatment Operations Team is lead by the Washington Aqueduct and its consultants. They will carry out the desktop studies that will lead to a recommended treatment approach as well as pipe loop studies to verify that approach and implement a partial, then full treatment process to reduce the corrosivity of the water.

This section presents Washington Aqueduct's Corrosion Reduction Plan that has been designed to evaluate previous work/studies performed by Washington Aqueduct, treatment process alternatives, system implementation of the alternatives and, the benefit of full-scale implementation of the optimized treatment in reducing the current potential corrosion issues in WA customer distribution systems. The approach of this Plan consists of four sections:

- Desktop Analysis;
- Partial System Application;
- Full-Scale implementation; and
- Monitoring process optimization via pipe-loop studies.

Desktop Analysis

To meet the requirements of the Lead and Copper Rule (LCR, {141.82(c), 56 FR 26550}) the Washington Aqueduct conducted a LCR mandated "Lead and Copper Rule Corrosion Control Study" in June 1994. In addition, Washington Aqueduct conducted a "Caustic Soda Feasibility Study" in October 1997 and a "Corrosion Inhibitor Study for Dalecarlia and McMillan Treatment Plants" in May 1998.

Washington Aqueduct will conduct a review of these documents in light of the LCR and recent water quality changes in customers distribution systems. Specifically, the information will be reviewed and incorporated into documentation recommending an OCCT that will be submitted to EPA for approval. The review will include:

1. A recommendation of optimum calcium passivation (elevated pH with sufficient alkalinity) while determining a feasible calcium carbonate precipitation potential (CCPP) that can be achieved for the Dalecarlia and McMillan water treatment plants (WTPs). The recommendation will evaluate a review of study findings to incorporate pH analysis and precipitation potential using either quicklime (current practice) and/or sodium hydroxide (caustic soda) and investigate the benefits and feasibility of moving the pH adjustment process upstream of the filters.
2. A determination of steps to be taken to optimize distribution system water chemistry prior to implementation of corrosion inhibitor feed facilities for a partial system and full-scale system application. The documentation review will evaluate optimized pH and chloramine residual levels that should be maintained to achieve maximum benefit from corrosion inhibitor feed.

3. Review existing corrosion inhibitor studies, literature and practices at other water treatment plants to determine comparable applications. Review findings with internal team (WA, CH2M Hill and Dr. Vern Snoeyink) and develop recommended corrosion inhibitor feed plan. Present the plan to the Technical Expert Working Group (TEWG) consisting of members from EPA, DC Department of Health (DC DOH), DC WASA, Washington Aqueduct, Falls Church, Arlington County and, consultants representing DC WASA and Washington Aqueduct.
4. The chemical regime that provides the greatest lead reduction while minimizing adverse impacts will be selected for partial system application.
5. Prepare OCCT document and submit to EPA for approval.

Partial System Application

Using the results obtained from the desktop analyses and input from electrochemistry and recirculating pipe loops from the Distribution System Operations Team, DC WASA and Washington Aqueduct will conduct a partial system application of what emerges as the preferred alternative in the Fourth (4th) High pressure zone. The 4th High pressure zone has elements consistent with other service zones in the WASA system including lead service lines (LSLs) as well as unlined cast iron pipe. Temporary chemical feed facilities will be set-up in the Fort Reno pumping. The temporary chemical feed facilities will be designed and installed for delivering the selected corrosion control treatment. The temporary facilities will be automated and will target the pH necessary for the treatment scheme previously determined during the desktop study. During this period, samples will be collected utilizing existing LCR sampling sites in addition to others that will be established prior to partial system applications start-up. This monitoring will significantly increase the number of water samples collected compared to normal system monitoring. The collected samples will be evaluated for:

- pH (field and laboratory);
- Alkalinity (as calcium carbonate {$CaCO_3$});
- Total and dissolved calcium;
- Turbidity;
- Total and dissolved lead;
- Temperature (field);
- Chlorine species;
- Dissolved oxygen;
- Oxidation/reduction potential
- Silica;
- Aluminum;
- Phosphate;
- Nitrogen species;
- Total coliform/E. coli; and
- Heterotrophic plate count bacteria

It is anticipated that the partial system application will be conducted over a period of three (3) months beginning June 1, 2004 and concluding at the end of August 2004.

Following completion of the partial system application all temporary testing equipment (chemical feed pumps, monitoring equipment, chemical storage units, etc.) will be removed from the Fort Reno facility and the pump station will be returned to pre-existing condition,

At the conclusion of the first three (3) months of the partial system application, a recommendation will be submitted to the TEWG for conducting full system implementation.

Full System Implementation

The full-scale implementation of the selected corrosion reduction plan will begin 3-months after initiation of the partial system application assuming that there are no lingering adverse effects associated with the partial system application. Following implementation of the agreed upon full-scale solution (by the TEWG) samples will be collected utilizing existing LCR sampling sites in addition to others that will be established prior to full-scale system application start-up. The collected samples will be evaluated for:

- pH (field and laboratory);
- Alkalinity (as calcium carbonate {$CaCO_3$});
- Total and dissolved calcium;
- Turbidity;
- Total and dissolved lead;
- Temperature (field);
- Chlorine species;
- Dissolved oxygen;
- Oxidation/reduction potential
- Silica;
- Aluminum;
- Phosphate;
- Nitrogen species;
- Iron
- Total coliform/E. coli; and
- Heterotrophic plate count bacteria.

Pipe Loop Studies

Pipe loop studies will be conducted beginning in mid April 2004. The pipe loop studies will be utilized as a technical tool to determine corrosion inhibitor dose, pH, inhibitor type and, system control. The pipe loops will be constructed at the Dalecarlia water treatment plant with the testing material consisting of DC WASA LSLs. LSL segments (approximately 6-inches in length) will be inserted into the assembly and one will be removed on a tri-monthly basis and sent to EPA Research and Development (R&D) Cincinnati, OH for inner scale analysis. The pipe loop assemblies will include unlined cast iron (if possible) segments as well as brass faucets.

The present pipe loop testing scenario will include the following five (5) assemblies:

1. A control loop with three (3) parallel segments of LSLs and coupons that utilizes Dalecarlia finished water;
2. One loop assembly (with three (3) parallel segments) run at pH 7.7 (+/- 0.1 pH units) with phosphate addition and full-scale chloramine addition (currently approximately 3.5 mg/L combined chlorine);
3. One loop assembly (with three (3) parallel segments) run at pH 7.7 (+/- 0.1 pH units) with phosphate addition and reduced chloramine addition (approximately 2.5 mg/L combined chlorine);
4. One loop assembly (with three (3) parallel segments) run at pH 7.7 (+/- 0.1 pH units) with phosphate addition and reduced chloramine addition (approximately 2.0 mg/L combined chlorine); and
5. One loop assembly (with three (3) parallel segments) run at high pH and reduced chloramine addition (approximately 2.5-3.0 mg/L combined chlorine);

The pipe loops will be run at a flow rate commensurate with full-scale system service line rates for a period of sixteen (16) hours and subsequently shutdown for a period of eight (8) hours to replicate typical household usage. During the 8-hour shut down six (6) hours will be quiescent with a trailing two (2) hour period for sample collection. The pipe loops will be controlled by a program logic control (PLC) methodology and therefore, self-controlled.

Samples will be collected during the two (2) hour window and evaluated for:

- pH (field and laboratory);
- Alkalinity (as calcium carbonate {$CaCO_3$});
- Total and dissolved calcium;
- Turbidity;
- Total and dissolved lead;
- Temperature (field);
- Chlorine species;
- Dissolved oxygen;
- Silica;
- Aluminum;
- Phosphate;
- Nitrogen species; and
- Iron.

Should distribution system conditions change following full-scale implementation, the pipe loop strategy may be changed accordingly.

Distribution System Operations Team

The Distribution System Operations Team's plan is to develop an extensive distribution system monitoring program. The monitoring plan will be used to assess conditions before and after a revised treatment change. Either as a part of that plan, or as a separate monitoring plan, WASA will design a sampling plan for purposes of assessing extent of the lead levels in homes without lead service lines.

Distribution System Baseline Monitoring

To provide a more extensive water quality database with regards to current water quality conditions, distribution system managers will supplement monitoring by collecting and analyzing additional samples. Parameters collected will relate to corrosion control as well as microbiological activity. One treatment option being considered is to further raise the pH. Depending on conditions, calcium carbonate can precipitate in the distribution system at elevated pH levels. Monitoring for precipitated calcium carbonate in the distribution system will be conducted. Analysis of the precipitate will be conducted to determine if the calcium carbonate is the result of precipitation or from undissolved lime. Gathering this baseline information will allow WASA to monitor these levels if the ph adjustment is selected as the revised optimal treatment. Also, water quality parameters from the existing Corrators (remote testing stations) will be obtained. Corrators can provide extensive data on metal leaching due to water corrosion in the distribution system.

Water quality monitoring will continue when the Aqueduct makes its annual switch from chloramination to free chlorine in spring of 2004. A comparison of the data with chloraminated water and free chlorine water will be made to assess differences in water quality and corrosion chemistry between the two disinfectant schemes. Distribution system monitoring will gather the information necessary to assess aluminum levels for later analysis on impacts to the make-up of pipe wall scale.

Oxidation/reduction potential (redox potential) will also be monitored. The purpose of this is to detect any changes in redox potential that may occur with any changes made to treatment. This will be done during the annual shift to free chlorine in the spring of 2004 and after the switch back to chloramines. Monitoring redox potential during partial and full system deployment of a revised corrosion control treatment will also indicate if the revised treatment will control redox potential shifts.

The Distribution System Operations Team will develop a sampling protocol for monitoring these parameters, as well as lead and copper levels throughout the partial system application and full system application of the revised corrosion control treatment. This will include a plan for analyzing the acquired data.

WASA will also be developing a plan for sampling and analysis of homes and other buildings – including schools and day care centers – in the District that are not known or suspected to be served by lead service lines to determine whether homes and other buildings not served by lead service lines may also be experiencing excessive concentrations of lead in the water. This sampling will follow EPA protocol. The Production Treatment Operations Team will use this data as input into the effectiveness of the revised corrosion control treatment.

Monitoring Effects of Revised Corrosion Control Treatment

The Distribution System Operations Team will continue to monitor for parameters described in the baseline monitoring program, as well as incorporate a detailed first flush tap water sampling protocol to monitor lead concentrations in customers homes. This plan will be a part of or may serve as their routine tap sampling program performed as required by the Lead and Copper Rule. This plan will be ready for monitoring the partial treatment system application area by the time the partial system application is scheduled to begin (targeted for June 1, 2004). The full monitoring plan, covering the entire distribution system, including the Virginia wholesale customers' distribution systems, will be completed by the expected start-up date for full system deployment of the revised corrosion control treatment (targeted for September 1,2004).

Analysis of Differences Between the WASA, Arlington County and Falls Church Distribution Systems

The Distribution System Operations Team will conduct a comparative analysis of the three distribution systems served by Washington Aqueduct. Experience to date indicates that the optimal corrosion control treatment employed by the Aqueduct has had different results in the various distribution systems. To ensure that the revised OCCT is effective throughout the service area, the team will look at existing data and perform additional sampling as necessary to make a recommendation to the Production Operations Team.

Flushing

For proper maintenance, distribution systems must be occasionally flushed to remove particulate matter and biofilm that will develop over time. This is especially important in light of an adjustment to the system chemistry. Each of the jurisdiction's distribution systems will undergo flushing at the direction of the distribution system manager to prepare for the revised optimal corrosion control treatment.

Study of Flushing Protocols

One recommendation was that WASA investigate the effects of flushing instructions for sample collection and their effects on sample results. Higher flushing rates may cause more pipe scouring and contribute more lead to the water sample, especially in particulate form. WASA conducted lead profiling studies at several residences in the District in December 2003, and January, February and March 2004. During these studies, several consecutive water samples are collected from the residence plumbing over a period of several hours. These samples are then analyzed to determine how lead levels vary over time and the fraction of particulate lead of the total. By tracking the variability, better flushing procedures for sampling were developed. The revised flushing procedures were incorporated into new instructions for residents.

Metal Loadings to Sewage Treatment Plant

A recommendation was to examine loadings to the Blue Plains Sewage Treatment Plant to determine if lead, zinc and copper levels increased suddenly after the Aqueduct's conversion to chloramination in November 2000. WASA conducted this analysis and found no indication of an increase in lead, copper or zinc levels detected in wastewater influent.

Galvanic Corrosion Related to Water Meter Replacement

A recommendation was made that galvanic corrosion of lead from pipes and fixtures could have been made worse by the installation of new water meters if dielectrics were used to electrically isolate customers' plumbing systems from the water mains in the street. WASA is conducting an investigation on this possibility. Early indications are that dielectrics were not used in the meter installations. More meter inspections are being conducted to fully rule out this possibility. Additionally, recommendations have been made that galvanic corrosion between lead and copper plumbing may be accelerated in the presence of chloramines. The existing copper meter setters that are directly connected to the lead service lines were reportedly installed in the 1980s. Confirmation that the meter setters were not recently installed is being confirmed.

Lead Profiling

In order to determine possible treatment solutions, it is important to obtain profiles of lead concentrations over time at the tap. The primary goal for profiling is to determine if the lead is in a particulate or dissolved form, as well as to determine if it is coming from the lead service line or from within the home. Particulate forms may indicate lead is breaking off of the pipe wall, while dissolved lead may indicate other possible causes such as dissolution through biological activity (i.e., biofilms) or chemical reactions. WASA will also collect data on other mineral particulates such as aluminum, iron and zinc to determine if these minerals are playing a role in increasing lead release from pipes and fixtures. The objective of this task is to obtain lead profile data from 10 residential homes containing lead service lines that have exceeded lead action levels (15 ppb).

The Distribution System Operations Team will also implement lead profiling in homes without lead service lines to more accurately gauge the characteristics of lead leaching from faucets, valves and fixtures.

Follow-up lead profiling will be undertaken in April after WA switches to free chlorine, to determine if changes in lead leeching occur during the free chlorine period. This may help determine if there is a difference between lead leaching rates when free chlorine is used and when chloramines are used.

Pipe Scale Analyses

EPA's Office of Research and Development in Cincinnati, Ohio will be conducting detailed analyses on the mineral build-up, or scale, that currently exists in District of Columbia lead service line pipe taken from service. This investigation will include x-ray diffraction analysis to determine the mineral make-up of the scale. Confirmatory analysis will be done using Xanes spectroscopy performed at Argonne National

Laboratories. A batch of lead service line pipe-wall scale will be sent to U.S. Geological Survey laboratories for complete elemental analysis. That will assist with the identification of minerals present at very low levels. Mineral composition of the pipe-wall scale may provide an important clue as to the cause of elevated lead levels in tap water.

Lead Leaching Rates

A study will be completed by researchers from the University of Washington to determine the rate that lead leaches from bronze alloy fixtures and lead service lines into water sitting in the lead pipe or fixtures. The purpose of this study is to determine how quickly, under current corrosivity conditions, the lead concentrations build up. This information will help in adjusting advice to consumers on how often they should flush their plumbing if they do not follow the advice to flush once per day and collect water in containers for a day to several days worth of drinking and cooking needs.

Electrochemical Pipe Loop Study

This section provides an overview of the short-term recirculation loop testing programs that DCWASA will undertake to provide additional data to the Production Treatment Operations Team. The purpose of these tests is to expediently screen a select group of treatment strategies to determine and verify chemical dosages. This pipe loop system will also be used to try to gain an understanding of the observed increases in lead levels in the customer's tap water since the establishment of OCCT.

Two separate recirculation loop-testing configurations will be performed

1) Electrochemical recirculation loop configuration
2) Water quality/stagnation flow loop configuration

The testing will include several treatment options (discussed below) and data will be obtained regarding water quality and operating conditions of each chemical treatment system.

Materials to be evaluated

The results of the lead profile studies indicate that lead service lines are the major contributor to high lead concentrations in drinking water. Therefore, the focus of the short-term bench testing program will be to study corrosion of lead service lines. Copper will also be evaluated as part of the electrochemical testing program because of the ease and relative low expense of adding copper coupons to the recirculation loops. WASA will follow with additional testing of copper, brass, and lead tin/solders as part of the water quality/stagnation flow loop tests at a later time once the lead service line evaluations are complete.

Chemical Regimes

(for both electrochemical and water quality/stagnation flow loop configurations)

The following chemical amendment strategies will be evaluated:

Strategy 1 – Control condition consisting of chloraminated finished water without any additional chemical treatment. (*This regimen will serve as a baseline comparison for the other test strategies.)*

Strategy 2 – Carbonate passivation adding lime to raise the pH to 8.5 - 9.0 (*Based on carbonate solubility model predictions, this chemical amendment will initiate the development of protective calcite scales on the lead service lines*.)

Strategy 3 - Corrosion inhibitor in the form of phosphoric acid at a dose of 10 mg/L as phosphate with the pH at 7.5. (*Phosphates are a documented inhibitor on many lead bearing surfaces. Given the short duration of the testing a high phosphate dose is necessary in order to rapidly passivate the lead surfaces and assess whether phosphate has a likely value as a corrosion inhibitor. Demonstration testing (if performed) would be performed at a lower dosage more typical of distribution system usage*.)

Strategy 4 - Corrosion inhibitor in the form of a 50/50 blended ortho/polyphosphate at a dose where the total phosphate is 2 mg/L with pH adjustment between 7.8 –8.0. (*Polyphosphates may have value in limiting copper pitting problems, as well as minimizing other distribution system problems (i.e. colored water). However, they may also enhance the mobilization of lead via sequestration. This testing regimen will determine whether polyphosphates can be used without potential adverse impact to lead release rates.*)

Strategy 5 – Establish chloramines residual at 1.0 mg/L and use phosphoric acid addition per Strategy 3. (*This strategy will determine the effectiveness of phosphate inhibitors in the presence of a lower concentration of chloramines*.)

Every effort will be made to insure that the inorganic chemistry of the recirculated water does not vary during the course of the testing regimens. This will include frequent water change-outs, and daily monitoring of basic water quality parameters such as carbonate distribution, pH , chloride and sulfate levels.

Electrochemical Testing

Electrochemical testing will be performed in accordance with the methodology for "Pipe Section Flow Cells" contained in "Internal Corrosion of Water Distribution Systems", second edition published by AWWARF.

Seven recirculation loops will be constructed, one for each chemical strategy and two for testing alternate scenarios to help determine the cause of the elevated lead levels.

Water Quality/Stagnation Flow Loop Configuration

The lead service lines are generally ¾ to 1-inch diameter. Approximately 3 linear feet is required to obtain a 250 ml sample for ¾-inch piping. A piping rack with 9 ft of lead piping will be needed in order to provide a sufficient volume for sampling. A pump will be provided to recirculate water at a maximum flow rate of 2 gpm corresponding to a velocity of 1.2 ft/sec.

Five loops will be constructed, one for each chemical strategy. Each loop will consist of a reservoir (35 gallon container), a transfer pump, appropriate valving, a lead piping specimen approximately 9 ft long and sampling cocks. A 3 ft section of the lead piping specimen will be equipped with an electrode that will continuously measure the electro potential. The electrical potential will be continuously monitored from each pipe segment.

Communications Team

EPA Region III will lead the communications team. It will carry out its responsibilities with input from the entire working group, agency public affairs specialists, community involvement staff, and any private contractor who may be hired to provide specialized communication of technical information, particularly health issues, to the general public on a large scale. Public involvement in the development and implementation of this plan will be encouraged and will play a key role in the plan's success.

The main objectives of the communications team will be:

- Highlight short-term solutions for reducing risk to lead exposure: Whatever the treatment solution selected, it may still be until the end of calendar year 2004 before lead levels begin to decline. The communications team will need to continue reminding consumers to follow the recommendation to flush their tap prior to collecting water for drinking. The Team will also highlight information regarding the distribution of point of use filters and how WASA will handle replacement filter cartridges until lead levels decrease below the action level.
- Regular progress updates will be communicated to news media and posted on the Internet.
- Communicate to the public advance notice of potential temporary shifts in aesthetic qualities of the water resulting from anticipated treatment adjustments during this research. This may include red (rusty) water, increases in total coliform bacteria (harmless indicator organisms), or increased deposition of calcium carbonate in customers' plumbing.
- Describe research strategies of public interest, such as identifying sampling locations for a partial system deployment and posting results, as appropriate.
- Communicate information and implementation plans of particular interest to environmental justice groups, neighborhood advisory councils and other community organizations.
- Continue to describe the goals of the Lead and Copper Rule so that people learn to accurately differentiate the lead action level from a health-based standard.
- Coordinate with public health agencies to help them communicate actual health-effects concentrations from lead in drinking water if a consensus number is reached through the use of EPA's integrated exposure uptake biokinetic model for lead exposure

Schedule

The recommended target dates of the approach milestones are presented below.

Milestone	Target date
Initiation of electrochemical pipe loop studies	March 15, 2004
Distribution of desktop analysis preliminary findings and recommendations to Working Group	March 24, 2004
Complete desktop options analysis and decision Point for treatment selection	April 1, 2004
Begin unidirectional flushing in partial distribution system application area	April 1, 2004
Treatment selection presented to full TEWG	April 15, 2004
Initiation of flow-through pipe loop studies	April 15, 2004
EPA tentative approval of revised OCCT	May 1, 2004
Implement comprehensive public communications plan	May 1, 2004
Hold Public Information Sessions on treatment option	May 2-14, 2004
Initiate partial distribution system application	June 1, 2004
Initiate full distribution system unidirectional flushing program	June 1, 2004
Begin system-wide deployment of revised OCCT	Sept. 1, 2004
Final EPA approval of revised OCCT	Dec. 31, 2004

Independent Peer Review Conducted (March 24, 2004 – Dec. 31, 2004)