CORROSION CONTROL TREATMENT

BASIC FEASIBILITY STUDY

COMMONWEALTH OF PENNSYLVANIA
Department of Environmental Protection

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DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Water Supply and Wastewater Management

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Authority:	Pennsylvania's Safe Drinking Water Act (35 P.S. §721.1 *et seq*.) and regulations at 25 Pa. Code Chapter 109.
Policy:	Department of Environmental Protection (DEP) staff will follow the guidance and procedures presented in this document to direct and support implementation of all large systems and medium and small water systems that exceed either the lead or copper action level under the drinking water management programs.
Purpose:	The purpose of this document is to establish a rational and reasonable basis for staff decisions which will promote quality, timely and consistent service to the public and regulated community.
Applicability:	This guidance will apply to all large systems and medium and small water systems that exceed either the lead or copper action level.
Disclaimer:	This guidance and procedures outlined in this document are intended to supplement existing requirements. Nothing in this document shall affect more stringent regulatory requirements. The guidance and procedures herein are not an adjudication or a regulation. There is no intent on the part of DEP to give this document that weight or deference. The guidance and procedures merely explain how and on what basis DEP will administer and implement its responsibilities with respect to all large systems and medium and small water systems that exceed either the lead or copper action level. DEP reserves the discretion to deviate from the guidance and procedures in this document if circumstances warrant.
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Definitions:	See 25 Pa. Code Chapter 109

CORROSION CONTROL TREATMENT
BASIC FEASIBILITY STUDY

BACKGROUND

The Lead and Copper Rule (LCR) requires all large systems and medium and small systems that exceed either the lead or copper action level to prepare corrosion control treatment (CCT) feasibility studies. Large systems must complete and submit their studies to the Department of Environmental Protection (DEP) by June 1994. Studies for medium or small systems must be submitted within 18 months of the date the action level was exceeded.

DEP encourages systems to conduct desktop evaluations of treatment alternatives with emphasis on the use of data from systems with successful corrosion control under analogous conditions. This basic feasibility study guide includes a desktop evaluation form and describes additional information required for a complete study. A water supplier that prepares a complete basic feasibility study in accordance with these instructions will generally comply with the LCR requirements pertaining to CCT studies, select the most feasible alternative, minimize the cost impact of treatment, and, in most cases, eliminate the need for demonstration testing.

PURPOSE

The purpose of the basic feasibility study is to identify corrosion control priorities, evaluate viable corrosion control approaches and select the optimal corrosion control treatment in a simplified format.

CONTENT

As a minimum, the system shall include the information required in a basic study described as follows:

1. A sample site location plan for lead and copper tap and water quality parameter monitoring.

2. A summary of all lead and copper and water quality parameter monitoring results. These results should be evaluated considering the location of sample sites within the distribution system and used as the basis for considering corrosion control treatment options.

3. A desktop evaluation of alkalinity and pH adjustment, calcium hardness adjustment, and corrosion inhibitor addition or a combination of these treatments. If source water treatment is needed to achieve optimal corrosion control, the water supplier shall evaluate the source water treatments including ion exchange, reverse osmosis, lime softening and coagulation/filtration. The evaluation shall recommend optimal corrosion control treatment and water quality parameter performance requirements for the selected treatment.

4. A proposed schedule for completion of the remaining corrosion control treatment compliance steps including, but not limited to, treatment design and permit application submittal, financing and construction, and initiation of operation.

DESKTOP EVALUATION FORM

To comply with the LCR requirements for CCT feasibility studies, the attached form may be completed and returned to DEP along with the above mentioned items.

Prior to beginning the desktop evaluation, the water supplier should consider the following:

1. The desktop evaluation form is intended to allow the user to review alternative treatments to achieve optimal corrosion control. In a step-by-step fashion, the form is designed to guide the user in compiling all the necessary information needed for this evaluation. The evaluation is intended to be a selective process whereby options are narrowed down based on theory, actual system operation and constraints.

2. All of the information requested on the first 13 pages, unless stated otherwise, must be completed in order to fully evaluate each treatment alternative. Final treatment recommendations are located on page 14. Indicate the recommendation that applies for your system and complete the remaining sections. A combination of treatment methods may be necessary to achieve optimal corrosion control.

3. At least two of the following resources should be utilized to support your recommendations:

   - DEP Analogous Treatment Program
   - Computer Model(s)
   - Engineering Report or Consultant Study
   - Literature
   - Internal Study
   - CCT Jar Testing

   Reports or summaries shall be attached to the form where applicable.

4. CCT jar testing is an important resource that can indicate to the user whether certain ranges of water quality parameters can be obtained with the recommended chemical and at what dosages. Jar testing involves treatment of a raw water sample with the addition of the selected chemical until the desired water quality parameter range has been reached. For most closed systems, the test should be conducted using a dissolved oxygen bottle. Jar testing may be performed in-house or by a consultant (laboratory or engineer).

5. References.

   USEPA. Drinking Water Regulations: Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR Parts 141 and 142.

   USEPA. 1992. Lead and Copper Rule Guidance Manual - Volume 2: Corrosion Control Treatment. Office of Ground Water and Drinking Water (Washington, D.C.). EPA 811-B-92-002.

AFTER THE STUDY IS COMPLETED

Water suppliers should submit the completed basic feasibility study to the DEP Regional Office serving the county where the water system is located. DEP water supply staff will review the study for completeness and technical merit and issue an approval upon correction of any deficiencies. DEP may require demonstration testing, which usually involves bench or full-scale testing using pipe loops or metal coupons, when a thorough desktop evaluation does not provide a confident treatment recommendation.

Following study approval, the water supplier must submit a construction permit application including plans and specifications for the CCT design. Large systems must submit a construction permit application by March 31, 1995. Medium and small systems must submit their construction permit application within 30 months of exceeding an action level. The facilities design should be based on the recommendations made in the feasibility study. Construction permit approval gives permission for the CCT facilities to be constructed. Contact the DEP Regional Office for more detailed information on permit requirements.

CORROSION CONTROL TREATMENT
BASIC DESKTOP EVALUATION FORM

A. PWS GENERAL INFORMATION

1. PWS Identification No.: ______________________________

   System Name: ______________________________

2. Contact Person

   Name: ______________________________

   Mailing Address: ______________________________

   ____

   Telephone No.: ______________________________

3. Population Served: ____________

4. Type of System:

   Groundwater ________ Surface Water ________ Consecutive ________

5. Average Daily Usage ______ TGD

6. Person responsible for preparing this form:

   Name: ______________________________

   Signature: ______________________________

   Telephone No.: ______________________________

B. MONITORING RESULTS

1. Sampling Dates: From __________________ To ________________________

2. First-Draw Tap Monitoring Results:
   Lead:
   - Minimum concentration = _________________ mg/L
   - Maximum concentration = _________________ mg/L
   - 90^{th} percentile = _________________ mg/L

   Copper:
   - Minimum concentration = _________________ mg/L
   - Maximum concentration = _________________ mg/L
   - 90^{th} percentile = _________________ mg/L

3. Entry Point Monitoring Results:

	Entry Point #				
	______	______	______	______	_____
Lead concentration, mg/L	______	______	______	______	_____
Copper concentration, mg/L	______	______	______	______	_____
*pH	______	______	______	______	_____
*Temperature, °C	______	______	______	______	_____
Alkalinity, mg/L as $CaCO_3$	______	______	______	______	_____
Calcium, mg/L as $CaCO_3$	______	______	______	______	_____
Conductivity, umho/cm @ 25 °C	______	______	______	______	_____
Orthophosphate, mg/L as PO_4 (if phosphate-based inhibitor used)	______	______	______	______	_____
Silica, mg/L as SiO_2 (if silica-based inhibitor used)	______	______	______	______	_____

4. Water Quality Parameter Distribution System Monitoring Results:

	Minimum	Maximum	Average
*pH	_________	_________	_______
Alkalinity, mg/L as $CaCO_3$	_________	_________	_______
*Temperature, °C	_________	_________	_______
Calcium, mg/L as $CaCO_3$	_________	_________	_______
Conductivity, umho/cm @ 25 °C	_________	_________	_______
Orthophosphate, mg/L as PO_4 (if phosphate-based inhibitor used)	_________	_________	_______
Silica, mg/L as SiO_2 (if silica-based inhibitor used)	_________	_________	_______

- **Does entry point concentration contribute significantly to concentrations of lead and/or copper at the tap? Yes _____ No _____**
  If yes, treatment must be evaluated to reduce lead and/or copper at the source.
- * Analysis must be performed in the field or within 15 minutes from the time when the sample was collected.
- Please complete additional pages for each monitoring period conducted.

C. RAW WATER QUALITY DATA

Complete the table below for **raw water quality data on each source prior to treatment**. Only one set of parameters is necessary if two or more sources are blended prior to treatment. If sources are alternated and have the same entry point, raw water quality parameters can be measured from one blended sample containing approximately the same ratios of water from each source as used over an average one-year period.

PARAMETER	RAW WATER SOURCE ENTRY POINT #				
	________	________	________	________	________
pH	________	________	________	________	________
Alkalinity, mg/L as $CaCO_3$	________	________	________	________	________
Conductivity, umho @ 25 °C	________	________	________	________	________
*Total Dissolved Solids, mg/L	________	________	________	________	________
Calcium, mg/L as $CaCO_3$	________	________	________	________	________
*Hardness, mg/L as $CaCO_3$	________	________	________	________	________
Temperature, °C	________	________	________	________	________
*Chloride, mg/L	________	________	________	________	________
*Sulfate, mg/L	________	________	________	________	________
Iron, mg/L	________	________	________	________	________
Manganese, mg/L	________	________	________	________	________

*Include if data is available

D. EXISTING TREATMENT INFORMATION

1. General:

Is treatment used? Yes _____ No _____

Indicate (check) Treatment Processes Used for Each Entry Point:

PROCESS	ENTRY POINT #				
	_______	_______	_______	_______	_______
Disinfection:					
Chlorine Gas	_______	_______	_______	_______	_______
Hypochlorite (liquid chlorine)	_______	_______	_______	_______	_______
U.V. Light	_______	_______	_______	_______	_______
Chloramines	_______	_______	_______	_______	_______
Other ________________________	_______	_______	_______	_______	_______
Iron & Manganese Treatment:					
Sequestration	_______	_______	_______	_______	_______
Chemical Name _______________					
Filtration	_______	_______	_______	_______	_______
Ion Exchange	_______	_______	_______	_______	_______
Other ________________________	_______	_______	_______	_______	_______
Softening:					
Ion Exchange	_______	_______	_______	_______	_______
Lime Addition	_______	_______	_______	_______	_______
Other ________________________	_______	_______	_______	_______	_______
Aeration	_______	_______	_______	_______	_______
Granular Activated Carbon	_______	_______	_______	_______	_______
Surface Water Filtration:					
Coagulation	_______	_______	_______	_______	_______
Flocculation	_______	_______	_______	_______	_______
Sedimentation	_______	_______	_______	_______	_______
Filtration:					
Single Medium	_______	_______	_______	_______	_______
Dual Media	_______	_______	_______	_______	_______
Multi-Media	_______	_______	_______	_______	_______
List Media ____________________					
Recarbonation	_______	_______	_______	_______	_______
Other ___________________________	_______	_______	_______	_______	_______

D. EXISTING TREATMENT INFORMATION (continued)

2. Existing Corrosion Control Treatment:

Is corrosion treatment currently used? Yes _____ No _____

Indicate (check) Treatment Processes Used

Phosphate Inhibitor ________________________________

Date Installed ________________________________

Type: Orthophosphate/Polyphosphate/Hexametaphosphate/Blend
(circle one of the above)

Brand Name ________________________________

Dosage _______________ mg/L

Average residual in distribution system:

Orthophosphate ________________ mg/L as PO_4

Total Phosphate ________________ mg/L as PO_4

How often is residual measured? ________________________________

Silicate Inhibitor ________________________________

Date Installed ________________________________

Brand Name ________________________________

Dosage ________________ mg/L

Average residual in distribution system _______________ mg/L as SiO_2

How often is residual measured? ________________________________

pH/Alkalinity Adjustment ________________________________

Date Installed ________________________________

Chemical(s) used ________________________________

Dosage ________________ mg/L

Average pH in distribution system ________________________________

Average alkalinity in distribution system _______________________ mg/L as $CaCO_3$

How often is pH and/or Alkalinity measured?________________________________

Calcium Adjustment (Precipitation) ________________________________

Date Installed ________________________________

Chemical(s) used ________________________________

Dosage ________________ mg/L

Average calcium measured at entry point _______________________ mg/L as $CaCO_3$

Average calcium measured in distribution system ________________ mg/L as $CaCO_3$

Average pH measured at entry point ___________________________

Average pH measured in distribution system ___________________

Average alkalinity at entry point ______________________________ mg/L as $CaCO_3$

Average alkalinity in distribution system _______________________ mg/L as CaC03

How often are parameters measured? ___________________________

D. EXISTING TREATMENT INFORMATION (continued)

3. Existing System Schematic:

   Provide a flow diagram of the system indicating all sources of supply, entry points and treatment processes.

E. DISTRIBUTION SYSTEM INFORMATION

Does the distribution system contain lead services lines? Yes _____ No _____

How often is the distribution system flushed? ____

Indicate the approximate percentages of materials in the distribution system:

PVC	__________________________________
Polyethlene	__________________________________
Cast Iron	__________________________________
Ductile Iron	__________________________________
Galvanized	__________________________________
Asbestos Cement	__________________________________
Steel	__________________________________
Concrete	__________________________________
Lead	__________________________________
Copper	__________________________________
Other ____________	__________________________________

F. HISTORICAL INFORMATION

Is there a history of water quality complaints? Yes _____ No _____
If yes, then answer the following:

Mark the general category of complaints below. Use:
1. for some complaints in this category
2. for several complaints in this category
3. for severe complaints in this category

Categories of complaints:

Taste and odor ______________________________
Color ______________________________
Sediment ______________________________
Other _________ ______________________________

Have there been any corrosion control studies done in the past? Yes _____ No _____
If yes, please indicate:

Date(s) of study ______________________________
Study conducted by PWS personnel? Yes _____ No _____

Brief results of study were:

____
____
____
____
____

Study results attached? Yes ________ No ________

Were treatment changes recommended? Yes ________ No ________

Were treatment changes implemented? Yes ________ No ________

Is treatment still in use? Yes ________ No ________
If not, why?

____
____
____
____

G. CORROSION TREATMENT CONSTRAINTS

Optimal corrosion control treatment means the corrosion control treatment that minimizes the lead and copper concentrations at user's taps while insuring that the treatment does not cause the water system to violate any national primary drinking water regulations. Please indicate using the codes below which constraints limit the feasibility of a particular corrosion treatment for your system and the severity of the constraint.

1. Some constraint = Potential impact but extent is uncertain.
2. Significant constraint = Other treatment modifications required to operate option.
3. Severe constraint = Additional capital improvements required to operate option.
4. Very severe constraint = Renders option infeasible.

Refer to Appendix A for more information on corrosion treatment constraints.

<u>CORROSION TREATMENT</u>

CONSTRAINT

	pH/ALKALINITY ADJUSTMENT	**CALCIUM ADJUSTMENT**	**INHIBITOR PO4**	**SiO$_2$**
A. REGULATORY				
SOCs/IOCs				
SWTR: Turbidity				
Total Coliforms				
SWTR/GWDR: Disinfection				
Lead and Copper Rule				
Radionuclides				

B. FUNCTIONAL				
Taste & Odor				
Wastewater Permit				
Aesthetics				
Operational				
Other				

H. DESKTOP EVALUATION

Indicate (check) sources used in determining optimal corrosion control treatment recommendations:

DEP Analogous Treatment Program	____________________
Computer Model(s)	____________________
Specify ____________________	
Engineering Report or Consultant Study	____________________
Literature	____________________
Internal Study	____________________
CCT Jar Testing	____________________
Other ______________________________	____________________

Briefly summarize the review of the corrosion control literature, reports, studies, or computer models utilized for your evaluation. A report or summary can be attached to this form where applicable.

____

____

____

____

If your analysis includes documented analogous treatments with other systems of similar size, water chemistry and distribution system configuration, indicate using the chart below the overall performance of the treatment in minimizing lead/copper corrosion at each of those systems. If two or more systems have the same treatment and that treatment performs at the same level in each system, you may indicate this by using a number in the appropriate block.

	Very Good	Good	Poor	Adverse
pH/Alkalinity Adjustment				
Calcium Adjustment				
Inhibitors: Phosphate Based				
Silica Based				

I. RECOMMENDATIONS

Include the optimal corrosion control treatment method or combination of methods and corresponding water quality parameters being proposed. The target entry point and distribution values should be specified as minimums or ranges.

pH/Alkalinity Adjustment ______________________________
- Chemical(s) ______________________________
- Target dose, mg/L ______________________________
- Target entry point pH ______________________________
- Target distribution pH ______________________________
- Target entry point alkalinity, mg/L as $CaCO_3$ ______________________________
- Target distribution alkalinity, mg/L as $CaCO_3$ ______________________________

Calcium Adjustment ______________________________
- Chemical(s) ______________________________
- Target dose, mg/L ______________________________
- Target entry point pH ______________________________
- Target distribution pH ______________________________
- Target entry point alkalinity, mg/L as $CaCO_3$ ______________________________
- Target distribution alkalinity, mg/L as $CaCO_3$ ______________________________
- Target distribution calcium, mg/L as $CaCO_3$ ______________________________

Inhibitor ______________________________
- Phosphate Based ______________________________
  - Type ______________________________
  - Brand Name ______________________________
  - Target dose, mg/L ______________________________
  - Target residual, mg/L as PO_4 ______________________________
- Silica Based ______________________________
  - Brand Name ______________________________
  - Target dose, mg/L ______________________________
  - Target residual, mg/L as SiO_2 ______________________________

Source Water Treatment ______________________________
- Ion Exchange ______________________________
- Reverse Osmosis ______________________________
- Lime Softening ______________________________
- Coagulation/Filtration ______________________________
- Target reduction in Lead/Copper after Treatment ______________________________

Rationale for the proposed optimal corrosion control treatment is:

Discussed in the enclosed report ______________________________
Briefly explained below ______________________________

____

____

____

J. PROPOSED TREATMENT INFORMATION

Proposed System Schematic:

Provide a flow diagram of the proposed system indicating all sources or supply, entry points and treatment processes. ***If available***, include feed pump information (make, model number, HP), sampling locations for process control, contact times and mixing conditions required to achieve a stable finished water.

APPENDIX A

CONSTRAINTS WORKSHEET FOR CORROSION CONTROL TREATMENT ALTERNATIVES

The LCR requires as part of the feasibility study that all constraints limiting the availability of corrosion control treatment alternatives be considered. The study should address constraints which cause a treatment alternative to adversely impact other water treatment processes or to otherwise be ineffective for the water system.

This appendix contains worksheets for each of the three basic treatment alternatives: pH/alkalinity adjustment, calcium adjustment, and corrosion inhibitors. The worksheets should assist the water supplier in identifying and evaluating the constraints acting on their systems.

Water suppliers should evaluate the impact of alternative corrosion control treatment options on compliance with existing and reasonably foreseeable future regulations. Part A of each worksheet lists the regulatory constraints. In addition, water suppliers should evaluate the functional constraints of each alternative. Part B of the worksheet includes the functional constraints which may render a corrosion control treatment alternative undesirable or infeasible.

The information in the worksheets should be used to determine the severity of a particular constraint for completion of Part G "Corrosion Treatment Constraints" of the Basic Desktop Evaluation Form.

CONSTRAINTS WORKSHEET FOR
pH/ALKALINITY OR CALCIUM ADJUSTMENT TREATMENT ALTERNATIVES

Adjusting pH/Alkalinity and/or calcium for corrosion control typically consists of increasing their levels to generate favorable conditions for lead and copper passivation or calcium carbonate precipitation.

A. NATIONAL PRIMARY DRINKING WATER REGULATIONS CONSTRAINTS

RULE	***CONSTRAINT***
Surface Water Treatment Rule	Reduced inactivation effectiveness of free chlorine if pH adjusted before disinfection.* Potential for interference with dissolved ozone measurements. May increase turbidity from post-filtration precipitation of lime, aluminum, iron, or manganese.
Groundwater Disinfection	Reduces inactivation effectiveness of free chlorine if pH adjusted before disinfection.* Potential for interference with dissolved ozone measurements.
Disinfection Byproducts	Higher THM concentrations from chlorination if pH adjusted before disinfection.* Reduced effectiveness of some coagulants for precurser removal if pH adjusted before coagulation.*
Coliform Rule	Potential for higher total plate counts, confluent growth, or presence of total coliform when chlorination is practiced.
Radionuclides	In-plant adjustments may affect removal of radioactive particles if precipitation techniques are used for coagulation or softening. Removal of radionuclides during softening may be linked to the degree of softening. Modifying softening practices to achieve corrosion control could interfere with removals.

*Unless operating restraints dictate otherwise, the optimum location for pH adjustment is after disinfection and near the entrance to the distribution system. If quicklime is used to adjust pH, for example, it needs to be added prior to filtration so inert material does not accumulate in the clearwell or enter the distribution system.

CONSTRAINTS WORKSHEET FOR pH/ALKALINITY OR CALCIUM ADJUSTMENT TREATMENT ALTERNATIVES
(continued)

B. FUNCTIONAL CONSTRAINTS

Increased potential for post-filter precipitation may give undesirable levels of aluminum, iron, or manganese.

Process optimization is essential. Additional controls, chemical feed equipment, and operator attention may be required.

Multiple entry points will require ph/Alkalinity adjustment at each entry location. Differing water qualities from multiple sources will require adjusting chemical doses to match the source.

The use of sodium-based chemicals for alkalinity or pH adjustments should be evaluated with regard to the total sodium levels acceptable in the finished water.

Users with specific water quality needs, such as health care facilities, should be advised of any changes in treatment.

Excessive calcium carbonate precipitation may produce “white water” problems in portions of the distribution system.

It may be difficult to produce an acceptable coating of calcium carbonate on interior piping for large distribution systems. High CCPP levels may eventually lead to reduced hydraulic capacities in transmission lines near the treatment facility while low CCPP values may not provide adequate corrosion protection in the extremities of the distribution system.

CONSTRAINTS WORKSHEET FOR INHIBITOR TREATMENT ALTERNATIVES

Corrosion inhibitors can cause passivation of lead and copper by the interaction of the inhibitor and metal components of the piping system.

A. NATIONAL PRIMARY DRINKING WATER REGULATIONS CONSTRAINTS

RULE	***CONSTRAINT***
Surface Water Treatment Rule	The application of phosphate-based inhibitors to systems with existing corrosion byproducts can result in the depletion of disinfectant residuals within the distribution system. Additionally, under certain conditions phosphate-based inhibitors may stimulate biofilms in the distribution system.
Groundwater Disinfection	Same as above.
Disinfection Byproducts	No apparent effects.
Coliform Rule	If corrosion byproducts are released after the application of inhibitors, coliforms may be detected more frequently and confluent growth is more likely.
Radionuclides	No apparent effects.

B. FUNCTIONAL CONSTRAINTS

Potential post-filtration precipitation of aluminum.

Consumer complaints regarding red water, dirty water, color, and sediment may result from the action of the inhibitor on existing corrosion byproducts within the distribution system.

Multiple entry points will require multiple chemical feed systems.

The use of sodium-based inhibitors should be evaluated with regard to the total sodium levels acceptable in the finished water.

The use of zinc orthophosphate may present problems for wastewater facilities with zinc or phosphorus limits in their NPDES permits.

Users with specific water quality needs, such as health care facilities, should be advised or any treatment changes.

RELATIONAL BEHAVIOR OF CHANGING WATER QUALITY CONDITIONS FOR CORROSION CONTROL TREATMENT AND OTHER WATER QUALITY/TREATMENT OBJECTIVES

WATER QUALITY CHANGE	***IMPACT***
Non-Softening WTPS: pH Increase - After Filtration	- Increase in TTHM formation - Decrease in haloacetic acid formation. - Increase in final turbidity when lime is used - Reduced disinfection efficacy. - Post-filtration precipitation of manganese.
Softening and Non-Softening WTPs: pH Increase - Before Filtration	- Reduced disinfection by-products precurser removal when alum coagulation is practiced. - Increase in TTHM formation. - Decrease in haloacetic acid formation. - Reduced disinfection efficacy unless at pH levels above 9.0. - Increased soluble aluminum levels when alum coagulation is practiced. - Increased removal of manganese. - Increased encrustation of filter media when excess calcium carbonate available. - Excess precipitation of calcium carbonate when available in pipe network near WTP.
Softening WTPs: pH Decrease - Before filtration	- Decrease in TTHM formation. - Increase in haloacetic acid formation. - Reduced encrustation of filter media. - Reduced soluble aluminum levels when alum is added during softening.
Alkalinity Increase	- Increase ozone demand for disinfection.
Alkalinity Decrease	- At very low levels, reduced coagulation performance when using alum.
Calcium Increase	- Increased encrustation of filter media when excess calcium carbonate available. - Excess precipitation of calcium carbonate when available in pipe network near WTP. - Increase scavenging of phosphate inhibitors used for either corrosion control or chelation. - If after filtration, finished water turbidity increases.
Calcium Decrease Softening WTPS	- Prevent excess precipitation of calcium carbonate in pipe network in WTP.
Phosphate Increase	- Stripping of existing corrosion byproducts in the distribution system causing aesthetic quality degradation and increasing HPC levels initially due to biofilm disturbances.
Silicate Increase	- May reduce useful life of domestic hot water heaters due to "glassification"; silicates precipitate rapidly at higher temperatures.

This and related environmental information are available electronically via Internet. For more information, visit us through PA PowerPort at http://www.state.pa.us or visit DEP directly at http://www.dep.state.pa.us (choose directLINK “drinking water publications”).

www.GreenWorks.tv - A web space dedicated to helping you learn how to protect and improve the environment. The site features the largest collection of environmental videos available on the Internet and is produced by the nonprofit Environmental Fund for Pennsylvania, with financial support from the Pennsylvania Department of Environmental Protection, 877-PA-GREEN.