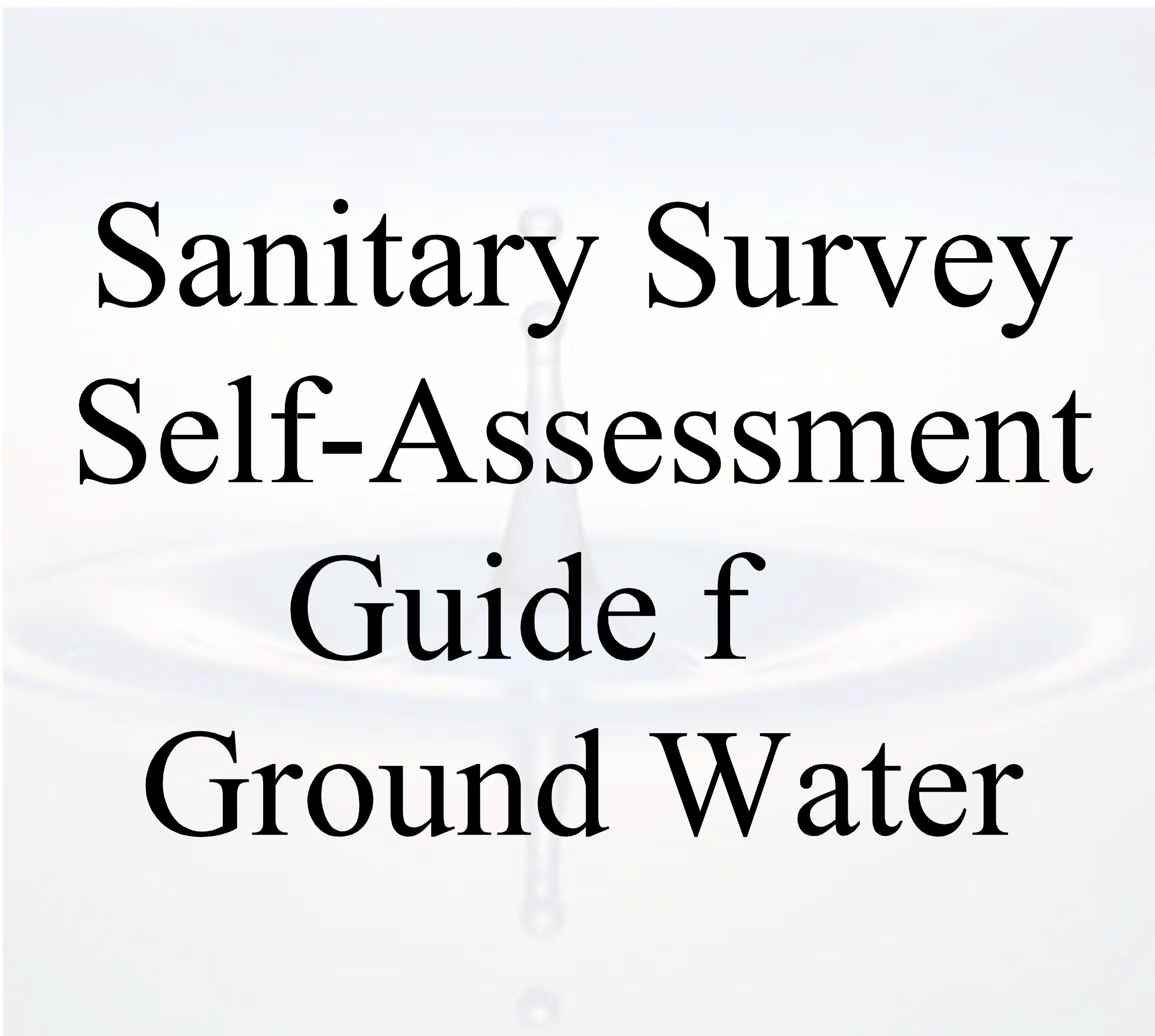
WESTERN KENTUCKY UNIVERSITY

Technical Assistance Center for Water Quality

Mr. Brents Dickinson



Sanitary Survey Self-Assessment Guide f Ground Water

TECHNICAL ASSISTANCE CENTER FOR WATER QUALITY

Sanitary Survey Self-Assessment Guide for Ground Water

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SANITARY SURVEY SELF ASSESSMENT GUIDE
For
GROUND WATER SUPPLIES

1.0 Preliminary Information:

Name of Utility: ___________________________________ Publicly Owned ___
Address: Street: ___________________________________ Privately Owned ___
City & Zip : ______________________________________
Phone : ______________________________________
Fax : ______________________________________
E-mail : ______________________________________
Person in Charge
Name____
Address: _______________________________________
Phone # Business: ________________________________
Phone # Home ________________________________
Are all services metered? Yes___No ___
How many metered? ___ How many customers _____
Does the system have an interconnection with neighboring systems? Yes __No __

2.0 SOURCE WATER PROTECTION

2.1 Source Water (Wellhead) Protection Plan

Phase I Includes

2.2 Planning Team formed Yes__ No__
2.3 The land to be protected has been identified (Delineation) Yes__ No __

Phase II Includes

2.4 Potential contaminants identified Yes__ No __
2.5 Plan developed to manage the source of contaminants Yes __ No __
2.6 Emergency (Contingency) plan developed Yes__ No __
2.7 Plan has been reviewed by the State and Certified? Yes __ No __

3.0 GROUNDWATER – GENERAL INFORMATION

3.1 Well sites and pumping

WELL #	1	2	3	4	5
Well Production					
Static Water Level					
Pumping Water Level					
Drawdown					
Well Yield (GPM)					
Specific Capacity GPM/FT)					
Pump Information					
Type					
TDH					
GPM					
Horse Power					

3.2 Well Test Records includes the following information:

Type of construction: Dug___ Drilled___ Bored ___ Driven___
Infiltration Lines___

3.2.1 Total Dynamic Head Yes __No __
3.2.2 Static water level Yes __No __
3.2.3 Depth of test pump Yes __No __
3.2.4 Time of start and end of each pump cycle Yes __No __
3.2.5 The zone of influence for each well Yes __No __
3.2.6 The Specific Capacity Yes __ No __

3.3 Quantity

The total ground water source capacity equals or exceeds the maximum day demand or Yes __ No __
Exceed the average day demand with the largest producing well out of service Yes __ No __
Standby power provided? Connection to two independent power sources ___ or
Portable or in-place auxiliary power ___

3.4 Location

Wells are located with regard to proper separation between sources of contamination (See Field Guide Section 3.4 page 5) Yes __ No __
Continued protection is provided by:
Ownership __Easements __Lease __ Other __
Well site is fenced Yes __ No __

4.0 General well construction

4.1 "As Built" or "Record Drawings" are available Yes __ No __

4.2 Casing pipe

4.2.1 Steel casing pipe meets AWWA Standard A-100 Yes __ No __
4.2.2 Nonferrous casing material approved by the reviewing authority Yes __ No __

4.3 Packing material type ____

4.4 Screens

4.4.1 Has sufficient length and diameter to provide specific capacity Yes __ No __
4.4.2 Entrance velocity does not exceed 1 foot/second. Yes __ No __
4.4.3 Provided with a bottom plate or washdown bottom fitting of the same material as the screen Yes __ No __

4.5 Grouting

4.5.1 Type of grout: Neat cement grout __ Concrete grout __Clay grout __
4.5.2 The casing is provided with sufficient guides welded to the casing to permit unobstructed and uniform thickness of grout. Yes __ No __

4.6 Upper terminal well construction

4.6.1 The permanent casing projects at least 12 inches above the pump house floor and at least 18 inches above the final ground surface. Yes __ No __

4.6.2 Well house floor is at least 6 inches above the final ground elevation
Yes__ No __

4.6.3 Sites subject to flooding:

4.6.3.1 Is provided with an earth mound, steel or concrete structure to raise the pump house at least 2 feet above the highest known flood elevation, and Yes __ No __

4.6.3.2 The top of the well casing terminates at least 3 feet above the 100-year flood or the highest known flood level, whichever is greater Yes __ No __

4.6.4 Well-casing vent is provided and above flood level Yes __ No __

4.6.5 Provisions are made for measurement of the water levels in the well
Yes __ No __

5.0 GROUNDWATER TREATMENT

5.1 Aeration Type: Natural draft __ Forced draft __ Packed tower __

5.1.1 Natural Draft Aerator – The design provides the following:

5.1.1.1 The distribution pan perforations are 3/16 to ½ inches in diameter and spaced 1 to 3 inches on center to maintain a 6-inch water depth. Yes __ No __

5.1.1.2 Discharges through a series of three or more trays separated by 12 inches or more Yes __ No __

5.1.1.3 Loading rate of 1 to 5 gallons per minute per square foot of total tray area Yes __ No __

5.1.1.4 Trays with slotted, heavy wire (1/2-inch openings) mess or perforated bottom. Yes __ No __

5.1.1.5 Construction of durable material resistant to aggressiveness of the water and the dissolved gases Yes __ No __

5.1.1.6 Louvers sloped to the inside at an angle of approximately 45 degrees Yes __ No __

5.1.1.7 Protected from insects by a 24-mesh screen. Yes__ No __

5.1.2 Forced Draft or Induced Draft Aerator is designed to

5.1.2.1 Include a blower with a weatherproof motor in a screened enclosure. Yes __ No __

5.1.2.2 Insure adequate counter current of air through the enclosed aerator column Yes __ No __

5.1.2.3 Exhaust air directly to the outside atmosphere Yes __ No __

5.1.2.4 Includes a down-turned 24 mesh screened air outlet and inlet.
Yes __ No __

5.1.2.5 Be such that air introduced in the column shall be free from obnoxious fumes, dust, and dirt Yes __ No __

5.1.2.6 Be such that sections of the aerator can be easily reached or removed for maintenance of the interior or installed in a separate aerator room Yes __ No __

5.1.2.7 Provides a loading rate of 1 to 5 gallons per minute per square foot of total tray area. Yes __ No __

5.1.2.8 Insure that the water outlet is adequately sealed to prevent the loss of air Yes __ No __

5.1.2.9 Discharges through a series of 5 trays or more, separated by six inches or more. Yes __ No __

5.1.1.10 Provides for uniform distribution of water over the top tray. Yes __ No __

5.1.2.11 Be of durable material resistant to the aggressiveness of the water and dissolved gases Yes __ No __

5.1.3 Packed Tower Aerator (Air Stripping)

5.1.3.1 Disinfection capability is provided before and after the packed tower. Yes __ No __

5.1.3.2 The packing material is resistant to the aggressiveness of the water and dissolved gases Yes __ No __

5.1.3.3 Water flow system provides – check all that apply

Uniform distribution at the top of the tower ___

A mist eliminator above the water distributor system ___

A side wiper-redistribution ring at least every 10 feet ___

Sample taps in the influent and effluent lines ___

A blow-off line in the effluent piping ___

Metering of water to the tower ___

An overflow line that discharges 12-14 inches above a splash pad or drainage inlet ___

5.1.3.4 The air flow system provides – Check all that apply

A 24-inch mesh down turned screen on the air inlet to the blower and the tower discharge vent ___

An air flow meter on the influent line ___

A back up motor for the air blower ___

5.1.4 Purpose

Gas transfer __Iron & manganese removal __Taste & Odor __

5.2 Lime-Soda Ash softening

5.2.1 Rapid Mix

5.2.1.1 Is equipped with mechanical mixing devices Yes __ No __

5.2.1.2 Has a detention time not more than 30 seconds Yes __ No __

5.2.2 Flocculation

5.2.2.1 Inlet - outlet design prevents short-circuiting Yes __ No __

5.2.2.2 Detention time is at least 30 minutes. Yes __ No __

5.2.3 Sedimentation

5.2.3.1 Provides a minimum of 4 hours detention time Yes __ No __

5.2.3.2 Inlet-outlet devices designed to prevent short-circuiting Yes __ No __

5.2.3.3 How is sludge removed? ______________________

5.2.4 Filtration – Rapid Sand Filter

5.2.4.1 Please indicate the type of media used in your filter:

Filter Sand __ Mixed Media __Dual Media __

5.2.4.2 Please indicate the depth of media ___, gravel ___

5.2.4.3 Indicate the type of underdrain system

Wheeler __ Leopold __ Pipe System __Other __

5.2.4.4 What is the approved rate of filtration for your filters?

_____ GPM/FT^2

and the approved backwash rate for your filters?

_____ GPM/FT^2

5.2.4.5 Filters are equipped with workable loss of head gages?

Yes __ No __

Filters are equipped with workable rate of flow controllers? Yes __ No __

5.2.5 Clearwell Storage

5.2.5.1 What is your clearwell capacity? ____________ Gallons

Express capacity as a percent of the design plant capacity.

___ %

5.2.5.2 If the ground water source is under the direct influence of surface water, what is the calculated CT[1] value for your plant?

___ mg/l.mins

Are you in compliance with the SWTR CT? Yes __ No __

5.3 Iron & Manganese Removal

5.3.1 By oxidation

5.3.1.1 By aeration __

5.3.1.2 By chemical oxidation - Check all that apply

Chlorine __

Potassium Permanganate __

Ozone __

Chlorine Dioxide __

5.3.2 By lime-soda ash method (see Section 5.2) __

5.3.3 By manganese greensand

5.3.3.1 Provision is made to feed potassium permanganate as far away as possible from the filter Yes __ No __

5.3.3.2 Provision is made to feed potassium permanganate immediately before the filter. Yes __ No __

5.3.3.3 An anthracite media cap of at least 6 inches is provided over the greensand. Yes __ No __

5.3.3.4 Rate of filtration is 3 gallons per minute per square foot

Yes __ No __

Rate of backwash is 8 to 10 gallons per minute per square foot

Yes __ No __

Air washing is provided Yes __ No __

5.3.3.5 Sample taps are provided – Check all that apply)

5.3.3.5.1 Prior to application of permanganate __

5.3.3.5.2 Immediately ahead of filtration __

5.3.3.5.3 At the filter effluent __

5.3.3.5.4 Points between the anthracite and the greens __

5.3.3.5.5 A point half way down the greensand __

[1] See Attachment 4 – Sanitary Survey Self Assessment Field Guide, Page 35

5.3.4 By ion exchange ____
This method should not be used when the concentration of iron, manganese, or a combination thereof exceed .3 mg/l

5.4 Chemical feeders

5.4.1 Liquid Chemical Feed System

5.4.1.1 The liquid chemical feed system has a pump capacity at least 10% larger than the maximum feed rate. Yes __ No __

5.4.1.2 All storage tanks containing liquid chemicals have an eyewash, shower, clear warning signs, berms for containment, and adequate lighting and ventilation. Yes __ No __

5.4.2 Dry Chemical Feeders

5.4.2.1 A dust collector unit and an exhaust fan are installed in the feeder room Yes __ No __

5.4.2.2 The hopper bottom has an angle no greater than 30^0 from the vertical and is fitted with a vibrator Yes __ No

5.4.2.3 Each dry chemical feeder has a calibration chart and is calibrated frequently. Yes __ No __

5.4.3 Gas Feed System

5.4.3.1 A solution feed vacuum pressure type feeder is used Yes __ No __

5.4.3.2 A direct gas feeder is used Yes __ No __

6.0 Chemical Treatment

6.1 Disinfection

6.1.1 Chlorine - Chlorine Equipment

6.1.1.1 Chlorination equipment – Check all that apply
Solution-feed gas chlorinator __
Hypochlorinator __

6.1.1.2 The equipment operates accurately over the desired range Yes __ No __

6.1.1.2 Standby equipment is available to replace the largest unit. Yes __ No __

6.1.1.4 Spare parts are available. Yes __ No __

6.1.1.5 Automatic switchover is provided to insure continuous disinfection Yes __ No __

6.1.1.6 Gauges for measuring water pressure and vacuum at the inlet and outlet of each eductor is provided Yes __ No __

6.1.1.7 The chlorine solution injector/diffuser is applied at the center of the pipeline Yes __ No __

6.1.2 Residual Chlorine

6.1.2.1 A minimum free chlorine residual of 0.20 mg/l is maintained at distant points in the distribution system Yes __No __

6.1.2.2 A minimum combined chlorine residual of 1.0 mg/l is maintained at distant points of the distribution system. Yes __ No __

6.1.3 Test Equipment – Chlorine residual test equipment is recognized in the latest edition of *Standard Methods for the Examination of Water and Wastewater* Yes __ No __

6.1.4 Chlorinator piping

6.1.4.1 The water supply to each eductor has a separate shut-off valve Yes __ No __

6.1.4.2 Pipes carrying elemental liquid or dry gaseous chlorine under pressure is Schedule 80 seamless steel tubing or material approved by the Chlorine Institute Yes __ No __

6.1.5 Chlorine Dioxide is used as a disinfectant. Yes __ No __

6.1.6 Ozone is used as a disinfectant Yes__ No __

6.1.7 Ultra Violet Light is used as a disinfectant Yes __ No __

6.2 Fluoridation

6.2.1 Fluoride chemicals used conform to AWWA standards Yes __ No __

6.2.2 Fluoride feed equipment used is – Check all that applies

Dry Chemical feeder

Volumetric __

Gravimetric __

Solution Feeder __

Fluoride saturator __

6.2.3 Fluoride injection point is at a point where all treated water must pass, such as the confluence of all filters Yes __ No __

6.2.4 Fluoride is not fed prior to lime softening Yes __ No __

6.2.5 Scales, loss-of-weight recorders, or liquid level indicators are provided Yes __ No __

6.2.6 Fluoride feeder is accurate within 5% of the desired feed rate. Yes __ No __

6.2.7 The electric outlet used for the fluoride feed pump is a non-standard receptacle. Yes __ No __

6.7.8 The electrical outlet used for the fluoride feed pump is connected to the well pump. Yes __ No __

6.3 Chemical Oxidation – Check chemical oxidants used and there purpose

6.3.1 Chlorine ___

6.3.1.1 Iron & Manganese removal ___

6.3.1.2 Color removal ___

6.3.1.3 Taste and odor control ___

6.3.1.4 Flocculent aid ___

6.3.2 Chlorine Dioxide ___

6.3.2.1 Iron & manganese removal ___

6.3.2.2 Color removal ___

6.3.2.3 Taste and odor control ___

6.3.3 Ozone ___

6.3.3.1 Iron and manganese removal ___

6.3.3.2 Color removal ___

6.3.3.3 Taste and odor control ___

6.3.4 Potassium Permanganate ___

- **6.3.4.1** Iron & manganese removal ___
- **6.3.4.2** Cyanide removal ___
- **6.3.4.3** Phenol Removal ___
- **6.3.4.4** Taste and odor control ___
- **6.3.4.5** Color removal ___

7.0 Plant Safety

Chemical Storage and Handling

7.1 Activated Carbon

- **7.1.1** "No Smoking" Signs are posted where carbon is stored or handled. Yes __ No __
- **7.1.2** Proper respiratory equipment is available for each operator Yes __ No __
- **7.1.3** Carbon is stored in single or double rows with access aisles around every stack Yes __ No __
- **7.1.4** The door to the carbon room is a self closing fire door Yes __ No __
- **7.1.5** Protective clothing is used when handling carbon Yes __ No __
- **7.1.6** Shower facilities are available to all operators handing carbon Yes __ No __
- **7.1.7** Non-explosive electrical outlets and fixtures are provided in the carbon room. Yes __ No __

7.2 Alum & Ferrous Sulfate

- **7.2.1** Proper respiratory equipment and chemical goggles are available for each operator Yes __ No __
- **7.2.2** Chemicals are stored in a clean dry place to avoid caking of chemicals from excessive moisture Yes __ No __
- **7.2.3** Loose, denim-quality, dust-proof, long sleeved clothing and a bandana and cap with trousers tied at the ankles are worn by operators when handling Alum and Ferrous Sulfate. Yes __ No __
- **7.2.4** Chemical solution pumps are equipped with antisplatter shields around the stuffing box. Yes __ No __

7.3 Lime

- **7.3.1** Proper respiratory equipment, dust goggles, and face shields are available for each operator. Yes __ No __
- **7.3.2** Quicklime is stored in a dry place not exposed to moisture.
- **7.3.3** Operators wear heavy denim clothing with long sleeves, bandana, trousers tied around the shoe, and covers exposed skin with protective cream. Yes __ No __
- **7.3.4** Showers are available to operators immediately after handling quicklime. Yes __ No __

7.4 Fluoride

- **7.4.1** Respiratory equipment, chemical goggles, rubber gloves, and protective clothing are worn by operators whenever handling sodium fluoride or sodium silicofluoride. Yes __ No __

7.4.2 Rubber boots and acid-proof aprons are worn by operators whenever handling hydrofluoric, fluosilicic, and hydrofluosilicic acid Yes __ No __

7.4.3 An eyewash fountain and emergency shower is in the immediate vicinity of the fluoride feeder. Yes __ No __

7.4.4 The fluoride chemical is stored in a location specifically designed for that purpose. Yes __ No __

7.5 Soda Ash (Sodium Carbonate)

7.5.1 Soda Ash is stored in a dry place not subject to moisture Yes __ No __

7.5.2 Chemical safety glasses, face shields, and rubber aprons are worn by operators when handing soda ash dust or solutions Yes __ No __

7.5.3 Equipment that handles soda ash solutions is equipped with spray or splashguards. Yes __ No __

7.6 Potassium Permanganate

7.6.1 Operators when handing this chemical wear gloves, respirators, eye protection, and protective clothing. Yes __ No __

7.6.2 Potassium Permanganate is stored in closed containers Yes __ No __

7.6.3 Potassium Permanganate is stored such that it can never come into contact with lubricants and carbon Yes __ No___

7.7 Chlorine

7.7.1 Electric chlorine detectors are installed in the chlorine room, in the chlorine storage room, and in the withdrawal room, with a sounding alarm and a warning light. Yes __ No __

7.7.2 A panic bar is located on the inside of door. Yes __ No __

7.7.3 The door to the chlorine room opens outward. Yes __ No __

7.7.4 All operators are supplied with a self-contained breathing apparatus (SCBA) or a supplied-air respirator while making repairs. Yes __ No __

7.7.5 All operators are trained in the proper use of SCBA or supplied-air respirator. Yes __ No __

7.7.6 Chlorine gas drills are conducted monthly. Yes __ No __

7.7.7 Ammonia solution is available for leak detection. Yes __ No __

7.7.8 Chlorine-leak repair kits are kept on hand for emergency repairs. Yes __ No __

7.7.9 An exhaust fan is located near the floor of the chlorine room. Yes __ No __

7.7.10 The switches to the exhaust fan are located outside the chlorine room and clearly marked. Yes __ No __

7.7.11 The chlorine room ventilation system interacts with the detection (alarm) system. Yes __ No __

7.7.12 The ventilation system in the chlorine room is designed to completely change the air in the room every 3 minutes. Yes __ No __

7.7.13 Operators wear rubber gloves, aprons, a dust respirator, goggles and a face shield when handling high-test hypochlorite (HTH). Yes __ No __

7.7.14 HTH containers are kept closed when not in use, and stored away from organic material. Yes __ No __

7.8 Sodium Chlorite

7.8.1 Sodium Chlorite is stored away from contact with any organic material that could cause an explosion or fire. Yes __ No __

7.8.2 Clothing contaminated with chlorite is washed before storing. Yes__ No __

7.8.3 SCBA or supplied-air respirators are available to operators when repairing leaks Yes __ No __

7.9 Ozone

7.9.1 SCBA or supplied-air respirators are available to operators when working with ozone. Yes __ No __

7.9.2 Operators are not exposed to ozone levels above 0.10 Mg/l Yes __ No __

7.10 Carbon Dioxide

7.10.1 No smoking signs are posted wherever carbon dioxide gas may be present. Yes __ No __

7.10.2 Generating equipment is located as close as possible to the point of application. Yes __ No __

7.10.3 Carbon monoxide testers are used before entering any closed recarbonation basin Yes __ No __

7.11 Anhydrous Ammonia

7.11.1 A bottle of hydrochloric acid is available to detect leaks. Yes __ No __

7.11.2 The ventilation system exhausts the air from the ceiling and brings in fresh air from the floor. Yes __ No __

7.11.3 Gas masks approved for use against ammonia are available for all operators. Yes __ No __

7.11.4 Masks and protective equipment are located in easy reach of where leaks are anticipated Yes __ No __

7.11.5 Rubber or neoprene one-piece suits, sealed at the ankles, wrists, and around the face; and SCBA or supplied-air respirators are available to operators when working in a high concentration of ammonia. Yes __ No __

7.11.6 Safety showers with a capacity of at least 30 gpm is available to operators. Yes __ No __

7.11.7 An eyewash station is located close to the equipment. Yes __ No __

7.12 Ammonium Sulfate

7.12.1 Ammonium Sulfate is secure from contact with quicklime or lime dust. Yes __ No __

7.12.2 Respiratory equipment and safety glasses or goggles are available to operators. Yes __ No __

8.0 Laboratory

8.1 General

8.1.1 All chemicals are dated on receipt and when initially opened Yes __ No __

8.1.2 An inventory of all laboratory chemicals is maintained Yes __ No __

8.1.3 The OSHA "*Hazard Communication Standard*" Or "Right to Know" regulations have been read by all employees in the laboratory.
Yes __ No __

8.1.4 Material Safety Data Sheets (MSDS) are maintained in a three ring notebook in the laboratory. See Attachment #5 Yes __ No __

8.1.5 The recommended safety equipment is maintained in the laboratory See Attachment #6 Yes __ No __

8.1.6 Eating, drinking, and smoking is prohibited in the laboratory Yes __No __

8.1.7 Food is never stored in laboratory refrigerators Yes __ No __

8.1.8 Acids and bases are stored in separate areas Yes __ No __

8.1.9 Flammable liquids are stored in safety cabinets or an explosion proof refrigerator Yes __ No __

8.2 **Is laboratory properly equipped**? Laboratory equipment checklist – See Attachment #7 Yes __ No __

8.3 **Lab Space**

8.3.1 Bench Space Adequate __Inadequate __

8.3.2 Lighting Adequate __Inadequate __

8.3.3 Housekeeping Excellent __Good __Fair __Poor __

8.3.4 Eyewash station is located in lab? Yes __ No __
Tested Monthly? Yes __ No __

9.0 Water Quantity

9.1 What is the 24-plant capacity? (GPD)(MGD) ____________________________

9.2 Is the safe yield adequate to meet the present and future demands? Yes __ No __

9.3 What was the average daily demand? (GPD)
Last year ______Last month ______ Last Week ________

9.4 What was the maximum daily demand
Last year ______Last Month ______ Last Week ________

9.5 Is the facility operating within its withdrawal permit? Yes __ No __
How much are you allowed to withdraw? GPD ______
How much are you withdrawing now? GPD ______

9.6 Does the utility have a conservation plan? Yes __ No __

10.0 Water Quality

10.1 Continuous Turbiditdometers sample each filter Yes __ No __

10.2 Continuous Turbiditdometers sample the confluence of all filters Yes __ No __

10.3 Continuous Chlorine residual recorders monitor the plant effluent Yes __ No __

10.4 Is the ground water source under the direct influence of surface water?
Yes __ No __

10.5 **Primary Drinking Water Standards –** See Attachment # 8

10.5.1 The plant maintains a list of all primary contaminants found in the water and the test results compared with the MCL of each contaminant found.
Yes __ No __

10.5.2 A copy of test results is provided Yes __ No __

10.6 Secondary Drinking Water Standard – See Attachment #9

10.6.1 A chemical analysis of the secondary standards is conducted each year on the raw and finished water Yes __ No __

10.6.2 A copy of the chemical analysis is provided Yes __ No __

10.7 Microbiological Sampling

10.7.1 How many samples are collected? ______

10.7.2 Do you have a sampling plan Yes __ No __

10.8 Lead & Copper Rule

10.8.1 Lead service line replacement requirements

10.8.1.1 Utility is removing and replacing all lead service lines owned by them Yes __ No __

10.8.1.2 If only a part of the lead service owned is replaced and removed, the customers are notified of a potential for a temporary increase in lead levels and measures they can take to reduce lead levels. Yes __ No __

10.8.2 Demonstration of Optimized Corrosion Control

10.8.2.1 The utility is optimizing corrosion control Yes __ No __

10.8.2.2 The utility has been deemed to be optimized and

10.8.2.2.1 Monitor for lead and copper samples every three years. Yes __ No __

10.8.2.2.2 Meets the copper action level Yes __ No __

10.8.3 The utility is delivering education to the public in compliance with the lead and copper rule. Yes __ No __

10.8.4 The utility is monitoring lead and copper in compliance with the Lead and Copper Rule. Yes __ No __

10.9 Radon Sampling

10.9.1 How many samples are collected? _______

10.9.2 Is there a sampling plan? Yes __ No __

11.0 Distribution & Cross Connection

11.1 Does the system have an ACCURATE system map that shows:

Pipe Size & Pipe Material	Yes __ No __
Valve Size and Location	Yes __ No __
Blow-off Locations	Yes __ No __
Storage tank location, size and overflow elevation	Yes __ No __
Hydrant location	Yes __ No __
Booster Pump locations	Yes __ No __
Sampling sites	Yes __ No __

11.2 What is the line pressure (PSI) in:

	Pressure Zone			
	1	2	3	4
Minimum				
Average				
Maximum				

11.3 What is the minimum free chlorine residual maintained? ____Mg/L
What is the minimum combined chlorine residual maintained? ____ Mg/L
11.4 Is booster chlorination required? Yes __ No __
If yes is it Gas __ Hypochlorination __
11.5 Does the system have a written and active cross-connection prevention plan?
Yes __ No __
11.6 Is the "unaccounted for" water calculated and recorded monthly?
Yes __ No __
11.7 Does the system have a meter-testing program? Yes __ No __

11.8 Storage Tanks 1 2 3 4

Volume (Gallons) ____

Overflow Elev. (FT) ____

Cathodic Protection ____

Telemetering ____

11.9 Booster Pumps 1 2 3 4

Horse Power ____

TDH ____

11.10 All distribution system operators are properly certified by the state regulatory agency Yes __ No __

12.0 Management

12.1 Type of ownership
12.1.1 Private ___
12.1.2 Public ___
12.2 Organization – The utility has an organizational manual Yes __ No __
12.3 Responsibility – The utility is in compliance with all local, state and federal laws and regulations. Yes __ No __
12.4 Fire Protection – The utilities distribution system is designed to provide fire protection. Yes __ No __
The ISO rating is _____
12.5 Permits – The utility has obtained all permits required. Yes __ No__
12.6 Regulations – The utility is in compliance with the SDWA and all amendments.
Yes __ No __
12.7 Water Rates
12.7.1 Revenue available shown in most recent audit. (Test Year)
12.7.1.1 Water sales Dollars $_____________
12.7.1.2 Penalties Dollars $ _____________

12.7.1.3 Tap fees Dollars $ ______________
12.7.2.4 Interest Dollars $ ______________

12.7.2 Revenue required during test year

12.7.2.1 Debt service Dollars $ ______________
12.7.2.2 Coverage on Debt Dollars $ ______________
12.7.2.3 Operation & Maintenance Dollars $ ______________
12.7.2.4 Capitalized Improvements Dollars $ ______________
12.7.2.5 Depreciation Schedule Dollars $ ______________

12.7.3 A billing analysis is available or records are maintained so that it can be easily produced? Yes __ No __

12.8 Accounting – The following reports are available and understood:
Balance Sheet Yes __ No __
Profit/loss Statement Yes __ No __

12.9 Office Operations – The utility has a procedural manual? Yes __ No __

12.10 Engineering
The utility has an in-house engineering staff? Yes __ No __
The utility utilizes a professional engineering firm? Yes __ No __

12.11 Standards – The utility maintains the following standards in their library?
American Water Works Association – AWWA Standards Yes __ No __
American Society of Testing Material – ASTM Standards Yes __ No __
American Standards Association – ASA Standards Yes __ No __

12.12 Equipment Maintenance
The utility maintains Preventative Records on all equipment Yes __ No __
The utility maintains unscheduled Breakdown Records Yes __ No __

12.13 Insurance – The utility maintains the following insurance
Comprehensive Yes __ No __
Property loss or damage Yes __ No __
Workman's Comp Yes __ No __
Public liability Yes __ No __
Employee health insurance Yes __ No __
Bonding of employees Yes __ No __

12.14 Personnel -
All personnel policies are in writing and available to all employees? Yes __No __
All employees are evaluated annually? Yes __ No __
There is a method for employees to discuss grievances and complaints Yes __ No __

12.15 In-service training is provided to all employees? Yes __ No __

12.16 Safety Programs **–** The Utility has a safety program to prevent accidents in the work place? Yes __ No __

12.17 Public Relations
The utility has a Public Relations department? Yes __ No __
The utility is a member of the local Chamber of Commerce? Yes __ No __

12.18 Annual Reports – The utility has published the CCR as required by EPA and on time? Yes __ No __

12.19 Employee handbook – The utility has an employee handbook? Yes __ No __

SANITARY SURVEY SELF ASSESSMENT FIELD GUIDE FOR GROUNDWATER SUPPLIES

1.0 PURPOSE: The purpose of this sanitary survey self assessment field guide is to empower managers and operators to determine whether they and their system have the capacity to be in and stay in compliance with the SDWA of 1974 and amendments of 1986 and 1996. This self-assessment document will be upgraded from time to time when new rules are promulgated by EPA that influence capacity development. It is the managers and operators that must do the job. By using this document managers and operators will understand the technical, managerial, and financial capacity needed to comply with the SDWA and reach the ultimate goal of protecting public health.

1.1 INTRODUCTION: A sanitary survey is defined as an on-site review of the water source, facilities, equipment, operation, and maintenance for producing and distributing safe drinking water, and would be considered a part of technical capacity. It is further defined in this document to include managerial and financial capacity.

Technical capacity includes the operation and maintenance of a water treatment plant, transmission and distribution, and the rules and regulations that govern the production and delivery of a potable water supply. The primary purpose of a water treatment plant is to produce a pathogen free and aesthetically acceptable drinking water (potable). The conditioning of the water to meet the primary and secondary drinking water standards is the duty of every operator.

The operator should endeavor to produce water that is:

a. Free of pathogens & other microorganisms
b. Free of toxic chemicals
c. Free of objectionable taste and odors
d. Clear and colorless
e. Chemically balanced (pH and Alkalinity for corrosion control.)
f. Economical to use
g. Within the state and EPA Drinking Water Standards

When you consider the responsibility of the operator, you realize how important the job is. Whether the plant is large or small, the job carries with it the same important responsibilities. All operators should possess the same knowledge in order to comply with the SDWA and the amendments that followed and those that will follow in future years. This is the goal of this document.

We will begin with source water protection and a short course on water treatment then follow with a discussion of the three rules that have already or will soon impact the water industry. i.e. The Consumer Confidence Reports or CCR (Attachment #1), the Disinfectant/Disinfectant By-Product Rule or D/DBP (Attachment #2),) and the Interim Enhanced Surface Water Treatment Rule or IESWTR (Attachment #3). These three new rules will be incorporated into this sanitary survey document.

2.0 SOURCE WATER (WELLHEAD) PROTECTION

2.1 INTRODUCTION

INTRODUCTION - Past experience has shown the water industry that it is far better to prevent contamination than to be surprised by an immediate and often potential danger to the water supply. The first line of defense in producing a potable water supply and protecting the public health begins with protecting the wellhead. Source Water Protection is an integral part of the multiple barrier concepts. It is a preventative effort aimed at eliminating unnecessary risk of contamination of the source water utilized by public water supplies. Wellhead protection is a community approach to protecting that community's drinking water. It identifies the origins of contaminates and determines the best way to manage them at the community level through the development of a protection plan.

A source water protection plan is designed to protect the water source used by a public water system from contamination. The plan identifies the protected areas in the zone of influence of each well, then inventoried to identify potential sources of contamination. Next, the management of these potential contaminants is considered, priorities are established, and recommendations are made to the local governing body. A source water protection plan is necessary to provide an early warning system in the event of a toxic spill or contamination within the area of influence.

A Wellhead Protection plan is a six-step process. The steps are:

a. Form a community planning team
b. Identify the land to be protected. (Delineation)
c. Identify potential contaminants
d. Develop a plan to manage the source of contamination
e. Plan for the future through emergency plan preparation, (Contingency Planning)
f. State plan review and certification.

2.2 COMMUNITY PLANNING TEAM

The community planning team should be made up of those people in the community that have a stake or other interest in protecting the source water. This would include the utility management; other utilities that purchase water from the source water utility and other business leaders in the community that are growth oriented. Emergency personnel should be a part of the community planning team and instructed to call the water plant if they respond to an accident in which a spill may endanger the source water.

2.3 DELINEATION OF PROTECTED AREA

For a ground water source the area to be protected is the zone of influence of each well.

2.4 POTENTIAL SOURCES OF CONTAMINATION

Local sources of contamination and the types of contaminates they generate should be identified. Possible sources of contamination could include:

a. Industrial sites
b. Buried gasoline tanks
c. Chemical warehouses
d. Recreation Sites
e. Golf Courses (Source of fertilizer& Pesticides)
f. Highways (Potential spill, gasoline, & Oil.)

These sources of contamination should be considered possible sites for spills. Land use information should be reviewed to pinpoint possible contaminants such as pesticides from agricultural use.

After the contaminants are identified, estimates of time of travel should be determined. In certain areas such as in the Karst regions of Kentucky and other states, ground water velocities are high and a contaminate could reach a surface stream or ground water quickly. Therefore, sinkholes in this area should be identified and protected by regulation or other means.

2.5 PLAN TO MANAGE SOURCE OF CONTAMINANTS

First, baseline water quality information is needed to determine if changes in water quality indicates contamination. Most water utilities have maintained this information for the traditional constituents and the inorganic contaminants for years. Now, with the EPA VOC regulations organic compounds are also included.

Second, considering what other water sources that may be available in case the current source becomes contaminated would be a prudent decision by the planning committee. If an alternate source is identified, their water quality, quantity, and vulnerability should be studied. An emergency interconnection with a neighboring system should be explored providing the neighboring system meets the quality, quantity requirements and do not have contamination problems.

Third, public education can focus community attention on restricting certain activities near the source. Ownership of the area within the zone of influence is also important. If the utility does not own the zone of influence or if the utility's jurisdiction is limited, measures can still taken by local legislation to control certain activities.

2.6 EMERGENCY RESPONSE PLAN

The information developed in the previous steps can be the foundation for an emergency response plan. An emergency response plan would include:

a. Temporary alternate source should be identified
b. A source of bottled water as needed.
c. A list of names and phone numbers of persons to contact for
   - Health effects
   - Monitoring
   - Treatment advice
d. An understanding of who does what, such as
   - Who will be the spokesperson
   - Who will coordinate with the state and other agencies
   - Who will be in charge of sampling
e. Have sample public notices and press releases on hand

Keep in touch with the water industry through your state primacy agency, AWWA, Rural Water Associations, and other utilities. Check with others who may have experienced an emergency. Find out what they did and what they would do differently.

Water utility managers often face difficult decisions to make as a result of increased public interest in safe drinking water and more complex regulations. The development of a management plan designed to deal with these problems will result in effective public relations and protect the public health. Let the public know that you are in charge, and that the water they are drinking is safe and risk free

3.0 GROUNDWATER GENERAL INFORMATION

3.1 Well Sites and Pumping - All wells should be tested and results recorded before placing on line. Yield and draw down tests should be performed on all production wells after construction or subsequent to treatment and prior to placement of the permanent pump. The test pump capacity should be at least 1.5 times the quantity anticipated, and provide continuous pumping for at least 24 hours or until stabilized drawdown has continued for at least 6 hours when test pumped at 1.5 times the design pumping rate.

3.2 Testing and Records – The well tests should provide the following information

- **3.2.1** Test pump head characteristics (TDH)
- **3.2.2** Static water level – the level (elevation) of the water table before pumping
- **3.2.3** Depth of test pump
- **3.2.4** Time of start and end of each pump cycle
- **3.2.5** The zone of influence for the well or wells.
- **3.2.6** The specific capacity expressed in GPM/Ft[2]

3.3 Quantity – The total ground water source capacity of all wells should equal or exceed the average day demand with the largest well out of service. It is also important to provide standby power to insure continuous service.

3.4 Location- When locating a well, consideration should be given to the proper separation between sources of potential or actual contamination. A well should not be less than:

- 50 feet from a septic tank
- 100 feet from septic tank absorption field
- 10 feet from a sewer
- 1000 feet from a solid waste disposal site
- Or near any open or abandoned wells

Continued protection of the wellhead would best be controlled by ownership of the zone of influence. If this is not possible, other means are available such as easements, or leases. All wellheads should be fenced.

4.0 General Well Construction

4.1 Casing Pipe - Permanent steel casing pipe should meet AWWA Standard A-100, ASTM or API Specifications for water well construction. Nonferrous material should be approved by the state reviewing authority.

4.2 Packing material – Packing shall be of material that will not impart taste, odor, toxic substances or bacterial contamination to the well water. Lead packers shall not be used.

4.3 Screens – Screens shall be constructed of material resistant to damage by chemical action of the ground water or cleaning material process and have openings based on the sieve analysis of the formation and/or the gravel pack material. The screen should have sufficient length and diameter to provide adequate specific capacity and a low entrance velocity. The entrance velocity should not exceed 1.0 ft/sec. It is also important that the pumping water levels remain above the screen during all pumping operations and be provided with a bottom plate or washdown bottom fitting of the same material as the screen.

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[2] Specific Capacity is a measure of the yield per foot of drawdown. For example: a pump rate of 320 GPM causes a 16-foot drawdown. The specific capacity is 320 GPM/16 Ft = 20 GPM/FT.

4.4 **Grouting –** All permanent well casing should be surrounded by a minimum of 1½ inches of grout to a depth required by the reviewing authority. The casing must be provided with sufficient guides welded to the casing to permit unobstructed flow and uniform thickness of grout.

4.5 **Upper Terminal Well Construction**

4.5.1 Permanent casings for all groundwater sources should project at least 12 inches above the pumphouse floor or concrete apron surface, or at least 18 inches above final ground level

4.5.2 When a well house is constructed, its floor surface should be at least 6 inches above the final ground elevation.

4.5.3 Sites subject to flooding shall be provided with an earth mound to raise the pumphouse floor 2 feet above the highest known flood elevation. The top of the well casing at the site subject to flooding shall terminate at least three feet above the 100-year flood or the highest known flood elevation.

4.5.4 The discharge piping should be designed for low friction loss, with control valves and other appurtenances located above the floor for easy access. Provisions must be made for venting the well casing to atmosphere. The well casing vent is provided to prevent vacuum conditions inside the well by introducing air. All vents should be turned downward in a vertical position and at least 36 inches above the floor or finished surface of the well lot and covered by a 24-mesh screen to prevent insects from entering the well. Screens subject to freezing temperatures should be checked to see that ice does not form on the screen that would prevent the entrance of air.

4.5.5 Provisions should be made for periodic measurement of water levels in the completed well.

5.0 GROUNDWATER TREATMENT

5.1 **Aeration –** Aeration may be used to remove offensive tastes and odors caused by dissolved gases from decomposing organic matter, or to reduce or remove carbon dioxide, and hydrogen sulfide. It is also used to introduce oxygen to assist in the oxidation and removal of iron and manganese. The packed tower (PTA) aerator, known as air stripping, involves passing water down through a column of packing material while pumping air counter-currently up through the packing. PTA is used to remove volatile organic chemicals, trihalomethanes, carbon dioxide, and radon. The types of aerators discussed here is the natural draft, forced draft and the packed tower

5.1.1 **Natural Draft Aerator –** design should provide:

5.1.1.1 Perforations in the distribution pan 3/16 to ½ inches in diameter, spaced 1 – 3 inches on centers to maintain a six-inch water depth and to distribute water uniformly over the top tray.

5.1.1.2 Discharge through a series of three or more trays with separation of trays not less 12 inches.

5.1.1.3 Loading at a rate of 1 to 5 gallons per minute per square foot of total tray area

5.1.1.4 Trays with slotted, heavy wire (1/2-inch openings) mess or perforated bottom

5.1.1.5 Construction of durable material resistant to aggressiveness of the water and the dissolved gases.

5.1.1.6 protection from the loss of spray water by wind carriage by enclosure with louvers sloped to the inside at an angle of approximately 45 degrees.

5.1.1.7 Protection from insects by 24-mesh screen.

5.1.2 Forced or Induced Draft Aerator – should be designed to

5.1.2.1 Include a blower with weatherproof motor in a tight housing and screened enclosure.

5.1.2.2 Insure adequate counter current of air through the enclosed aerator column.

5.1.2.3 Exhaust air directly to the outside atmosphere

5.1.2.4 Include a down-turned and 24-mesh screened air outlet and inlet.

5.1.2.5 Be such that air introduced in the column shall be free from obnoxious fumes, dust, and dirt.

5.1.2.6 Be such that sections of the aerator can be easily reached or removed for maintenance of the interior or installed in a separate aerator room.

5.1.2.7 Provide loading at a rate of 1 – 5 gallons per minute per square foot of total tray area.

5.1.2.8 Insure that the water outlet is adequately sealed to prevent the loss of air

5.1.2.9 Discharge through a series of five or more trays with separation of trays not lees than 6-inchs.

5.1.2.10 Provide distribution of water uniformly over the top tray

5.1.1.11 Be of durable material resistant to the aggressiveness of the water and dissolved gases.

5.1.3 Packed Tower Aerator (Air Stripping) – Generally, PTA is feasible for compounds with a Henry's constant greater than 100 atm/mol/mol and not normally feasible when Henry's Constant is less than 10. For values of Henry's Constant between 10 – 100, PTA may be feasible but should be evaluated by a pilot study.

In the past stripping practices have dealt with contaminants that are highly volatile such as hydrogen sulfide and carbon dioxide. The class of chemicals known as VOC's and their associated subset trihalomethanes (THM) are, however, less volatile and require more sophisticated equipment, i.e, packed towers.

5.1.3.1 The design should consider potential fouling from calcium carbonate, iron precipitation, and bacterial growth. It may be necessary to provide pretreatment. Therefore, disinfection should be provided before and after PTA.

5.1.3.2 The packing material should be resistant to the aggressiveness of the water, dissolved gases and cleaning materials and be suitable for contact with potable water.

5.1.3.3 The water flow system should provide:

a. Uniform distribution at the top of the tower using nozzles or orifice-type distributor trays that prevent short-circuiting

b. A mist eliminator above the water distributor system
c. A side wiper-redistribution ring at least every 10 feet in order to prevent channeling along the tower wall and short-circuiting.
d. Sample taps in the influent and effluent piping
e. A blow-off line in the effluent piping to discharge the water/chemicals used in the cleaning process
f. For the metering of the flow to the tower
g. An overflow line that discharges 12-14 inches above a splash pad or drainage inlet that carries the wastewater away from the foundation.

5.1.3.4 The air flow system should provide:
a. 24-mesh down turned screen on the air inlet to the blower and the tower discharge vent to prevent contamination from extraneous matter.
b. An air flow meter on the influent line
c. A backup motor for the air blower.

5.1.2 Purpose of Aerator: Gas transfer __Iron/manganese removal ___________
Taste and odor ___________________________

5.2 Lime-Soda Ash Softening – The basic principles of softening involve precipitating calcium as calcium carbonate, magnesium as magnesium hydroxide, and the non-carbonate hardness of calcium as calcium carbonate.

5.2.1 Rapid Mix

5.2.1.1 The rapid mix should be equipped with a mechanical mixer. The speed of the mixer should be designed to dissolve the chemicals without breaking up the floc or precipitate formed.

5.2.1.2 The detention time should be not more than one minute nor less than 30 seconds. The 10 States Standards suggest that two rapid mixers, flocculators, and sedimentation basins or upflow clairifiers should be used.

5.2.2 Flocculation

5.2.2.1 The inlet and outlet design of the flocculator should prevent short circuiting and

5.2.1.3 Provide a retention time between 30 – 45 minutes.

5.2.3 Sedimentation

5.2.3.1 The sedimentation basin or upflow clairfier should provide at least a 2-hour retention time and

5.2.3.2 The inlet and outlet should be designed to prevent short-circuiting.

5.2.4 Filtration

5.2.4.1 Filter sand should have an effective size[3] between .45 - .55 millimeters and a uniformity coefficient[4] should not exceed 1.65.

5.2.4.2 The depth of sand should be between 24 – 30 inches placed over a layer 12 – 18 inches of gravel.

5.2.4.3 An underdrain system is provided to evenly distribute the flow of water when filtering or backwashing.

[3] The effective size is that size that 10% of the sand grains is still smaller
[4] The Uniformity Coefficient is the ratio between effective size and that size that 60% of the sand grains are smaller.

5.2.4.4 The rate of filtration is 2.0 gpm/square foot of filter surface area with a backwash rate of 15 gpm/square foot.

5.2.4.5 The filters are equipped with rate of flow controllers and loss of head gages to regulate the flow of water through the filters and timing of the backwash cycle.

5.2.4 Clearwell Storage

5.2.4.2 A clearwell is provided to store the finished water prior to pumping to the distribution system. In Kentucky, a volume equal to 15% of the 24-hour capacity is required. This is to allow the plant to continue pumping to the distribution system when minor repairs are needed and to provide contact time for disinfection.

5.2.4.3 The Surface Water Treatment Rule (SWTR) was developed by EPA to protect the public from waterborne disease caused by *Cryptosporidium* oocycts, *Giardia* cycts, viruses, and other microorganisms. Therefore a rule was developed that requires all surface water and ground water directly under the influence of surface water to remove or inactivate disease-causing microorganisms. Because of the difficulty of monitoring these microorganisms, a treatment technique is required instead of a MCL. The treatment technique requires that complete treatment (coagulation, flocculation, sedimentation, filtration, and disinfection) be provided. These pathogens may be removed by coagulation, flocculation, sedimentation, filtration step, and inactivated by disinfection. CT[5] calculations are used to measure the performance of the treatment plant in meeting the requirements of the rule.

The SWTR & Interim Enhanced Surface Water Treatment Rule (IESWTR) specifies the following CT values.
Cryptosporidium – 2 log or 99.00% removal/inactivation
Giardia – 3 log or 99.90% removal/inactivation
Viruses – 4 log or 99.99% removal/inactivation
The CT calculations are shown in an example on Attachment 4.

5.3 Iron & Manganese may be removed by oxidation, followed by detention, and sedimentation; by lime-soda ash softening; manganese green sand; and by ion exchange.

5.3.1 – By oxidation

5.3.1.1 Oxidation may be accomplished by aeration as discussed in Section 5.1.

5.3.2.2 Chemical oxidation is accomplished by the use of several oxidants such as chlorine, potassium permanganate, ozone, and chlorine dioxide. These oxidants are discussed in Section 6.1.

5.3.1 Iron & Manganese is removed by lime-soda ash softening. See Section 5.2.

5.3.2 Manganese is removed by manganese green sand. In this process the following should be considered:

5.3.3.1 Provision should be made to feed potassium permanganate as far away as possible from the filter.

[5] CT is the product of the disinfectant concentration (C) in mg/l and the time (T)in minutes.

5.3.3.2 Provision should be made to feed potassium permanganate immediately before filtration.

5.3.3.3 Provide an anthracite media cap of 6 inches over the green sand

5.3.3.4 The design rate of filtration is 3 gpm/ft^2 and a backwash rate of 8 to 10 gpm/ft^2. Air washing may also be provided.

5.3.3.5 Sample taps are provided at the following locations

5.3.3.5.1 Prior to the application of potassium permanganate

5.3.3.5.2 Immediately ahead of filtration

5.3.3.5.3 At the filter effluent

5.3.3.5.4 Points between the anthracite and green sand, and

5.3.3.5.5 A point half way down the green sand

5.3.4 Iron may be removed by ion exchange if the raw water contains less than 0.3 mg/l iron, manganese or a combination thereof.

5.4 **Chemical Feeders –** There are three types of chemical feeder systems used in water treatment: liquid chemical, dry chemical, and gas feed.

5.4.1 Liquid chemical feeders are preferred because clean, compact, not labor intensive, has easy automatic controls, and does not have problems with dust or fumes.

5.4.1.1 The simplest and most cost effective liquid chemical feeder has a pump capacity at least 10% greater than the maximum feed rate. A rotdip feeder may be added to keep pace with the plant flow rate.

5.4.1.2 All storage tanks containing liquid chemicals should have an eyewash, shower, clear warning signs, berms, and adequate lighting and ventilation.

5.4.2 Dry chemical feeders can be easily automated and problems with dust can be minimized with the appropriate control system. However, dry chemical feeders are more labor intensive than the liquid chemical feeders. Eve though dry chemical feeders are not the preferred choice, some chemicals come only in dry form. (lime, potassium permanganate, PAC, and most anionic and nonionic polymers) The basic types of dry chemical feeders are volumetric and gravimetric.

5.4.2.1 A dust collector unit and exhaust fan should be installed in the feeder room to control dust.

5.4.2.2 For any solid material, especially the powered form, the angle of the hopper bottom is an important issue. The hopper bottom should have an angle no greater than 30^0 from the vertical and fitted with a vibrator.

5.4.2.3 Dry chemical feeders should be calibrated frequently with a dated calibration chart attached to the feeder.

5.4.3 Gas feed system – Chemicals in gas form are usually fed into the process water as a solution. (Exceptions are ozone and carbon dioxide) The liquid gas is converted into a solution by a hydraulic eductor and feed into the process water. The liquefied gas is injected into process water by a

5.4.3.1 Vacuum pressure feed system or

5.4.3.2 Direct gas feed system

6.0 CHEMICAL TREATMENT

6.1 DISINFECTION

6.1.1 CHLORINATI0N: Chlorine is still the disinfectant of choice because:

- It has been proven to be effective
- Has a low capital and operating costs
- Water treatment operators have had extensive experience with it
- Provides a residual

6.1.1.1 Chlorine Equipment

6.1.1.1.1 A solution-feed gas chlorinator or a hypochlorinator must be provided.

6.1.1.1.2 The chlorinator capacity should be such that a free chlorine residual of at least 2.0 mg/l may be maintained in the water after a 30-minute contact time when the maximum flow rate coincides with the anticipated maximum chlorine demand.

6.1.1.1.3 The equipment should be designed so that it will operate accurately over the desired feeder range.

6.1.1.1.4 Standby equipment should be provided to replace the largest unit.

6.1.1.1.5 Spare parts should be made available to replace parts subject to ware and breakage.

6.1.1.1.6 Automatic switchover of chlorine cylinders should be provided to insure continuous disinfection.

6.1.1.1.7 Each eductor should be selected for the point of application with particular attention given to the quantity of chlorine to be added, the maximum injector water flow, the total discharge back pressure, the injector operating pressure, and the size of the chlorine solution line. Gauges for measuring water pressure and vacuum at the inlet and outlet of each eductor should be provided.

6.1.1.1.8 The chlorine solution injector/diffuser must be compatible with the point of application to provide a rapid and through mix with all of the water to be treated. The center of the pipeline is the preferred application point.

6.1.1.2 Chlorine residual

6.1.1.2.1 The minimum free chlorine residual at the distant Points in the distribution system should be 0.2 to 0.5 mg/l.

6.1.1.2.2 The minimum combined chlorine residual at the distant points in the distribution system should be 1.0 to 2.0 mg/l.

6.1.2 CHLORINE DIOXIDE

Chlorine Dioxide is unstable at extremely high concentrations and must be generated on site. Chlorine Dioxide is generated from the reaction of sodium chlorite with chlorine gas or hypochlorous acid.

6.1.3 OZONE (0_3) is an allotrope (another form) of oxygen and is a highly reactive gas that is formed by electrical discharges in the presence of oxygen. Its most distinguishing characteristic is a very pungent odor. Ozone comes from a Greek word that means, "to smell".

6.1.4 ULTRA VIOLET LIGHT (UV) is discussed as a disinfectant, not as a chemical process. UV was established by 1910 when the mercury vapor lamp was enclosed in a quartz sheath. The quartz sheath was developed to dampen the effects of temperature changes on the water and light. Ultraviolet irradiation (emission of radiant energy) is produced in commercially available lamps by converting electrical power to light and heat.

A key design feature of the UV reaction chamber is that it must operate in plug flow[6]. Dispersion in the direction of flow must be kept to a minimum. Turbulence perpendicular to the direction of flow is necessary to provide mixing to overcome the nonuniform UV intensity field in the reactor.

There are three principle factors used to determine the effectiveness of UV light inactivation of microorganisms:

- Wavelength – measured in nanometers (nm)
- Intensity of UV light is measured in Microwatts per square centimeter (mW/cm^2)
- Exposure time in seconds (s) … thus
- Dosage is measured (Intensity x Time) in Microwatts.seconds per square centimeter. ($mW.s/cm^2$)

The disadvantages of UV disinfection is that:

- Requires pretreatment for surface water. Turbid water will absorb UV light and mask microorganisms.
- Does not provide a disinfectant residual

6.2 FLUORIDATION is the practice of adding fluoride to the water supply to reduce tooth decay. A brief history of fluoridation in the United States follows:

- In the 1930's and 1940s, studies determined that fluoride added to drinking water reduced dental caries.
- In 1950, the US Public Health Service, (USPHS) endorsed fluoridation.
- In 1962, the USPHS set fluoride levels in drinking water at 0.7 mg/l in warmer climates and 1.2 mg/l in colder climates.
- Since 1974, the US Environmental Protection Agency has regulated drinking water. In the 1986 amendments to the SDWA, EPA set an MCLG and an MCL for fluoride of 4.0 mg/l as a part of the Primary Regulations. A MCLG is a health related goal and an MCL is a technologically feasible goal.
- The Primary Regulations are enforceable and require that excessive fluoride be removed.
- A secondary MCL was set at 2.0 mg/l to protect against dental fluorosis.

6.2.1 CHEMICALS USED IN FLUORIDATION include Sodium Fluoride (NaF) AWWA Standard B701, Sodium Fluorosilcate (Na_2SiF_6) AWWA Standard B702, and Fluorosilicic Acid (H_2SiF_6) AWWA Standard B703. Prior to 1992, sodium flurosilicate was known as sodium silicofluoride and fluorosilicic acid was called hydrofluosilicic acid.

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[6] Plug flow is defined as pipeline flow or perfect flow. Plug flow has a high length to width ratio and considered perfect baffling.

Sodium Fluoride is a white, odorless material available either as a powder or in the form of crystals. It has a molecular weight of 42.00, a specific gravity of 2.79, and is available in purities ranging from 97 to 98 percent. Approximately 19 pounds of sodium fluoride will add 1.0 mg/l of fluoride to 1.0 million gallons of water.

Sodium Fluorosilcate (Sodium Silicofluoride) is a white, odorless, crystalline with a molecular weight of 188.06, a specific gravity of 2.679 and is available in purities above 98 percent. Approximately 14 pounds of sodium fluorosilcate will add 1 mg/l of fluoride to 1.0 million gallons of water.

Fluorosilicic acid has a molecular weight of 144.08 and is available in 20 – 35 percent aqueous solutions. Fluorosilicic acid should be handled with great care, because it has a low pH (1.2) and will cause a "delayed burn" on skin tissue. Approximately 46 pounds of 23% acid are required to add 1.0 mg/l of fluoride to 1.0 million gallons of water.

6.2.2 FLUORIDE FEEDER SYSTEMS include:

- Dry Chemical feeders with a dry fluoride compound
  - Volumetric – delivers a measured volume of dry chemical per unit time.
  - Gravimetric – delivers a measured weight of dry chemical per unit time.
- Chemical solution feeder with liquid fluoride compound or with a prepared solution of dry chemical.
- Fluoride saturator

6.2.3 FLUORIDE INJECTION POINTS (as most other chemicals) should be at a point where all water to be treated must pass. The best place would be a common point of all filter effluents leading to the clearwell after all other chemicals have been added, except for disinfectants. Other considerations in selecting a fluoride injection point are where not to feed fluoride. For example:

- Consideration of possible fluoride losses in filters. Problems may occur when a high dose of alum is used or manganese is present and the lime-soda ash softening process is used.
- When other chemicals are being fed, chemical compatibility must be considered. The fluoride should be as far away as possible from the addition of chemicals containing calcium to prevent the loss of fluoride by the precipitation of calcium fluoride.

References:

American Water Works Association Manual of Water Supply Practice (AWWA 34) *Water Fluoridation Practices*

American Water Works Association, *Water Quality and Treatment*, Fourth Addition, McGraw-Hill Inc.

6.3 CHEMICAL OXIDATION plays an important role in water treatment.

Chemical oxidants are added:

- At the intake or to the source water to control algae and other biological growth that may cause taste and odor problems.
- At the rapid mix:
  - As a disinfectant
  - To remove color

- Control taste and odor
- Reduction of specific organic pollutants
- Precipitation of iron & manganese

- The filter effluent as a final step as a disinfectant.

The oxidants used in water treatment include:

- Chlorine
- Chlorine dioxide
- Ozone
- Potassium permanganate

The principle of oxidation involves the exchange of electrons between species so as to change the valance. Oxidation should be referred to an oxidation-reduction reaction, because one species losses electrons or is oxidized while the other gains electrons or is reduced.

6.3.1 Chlorine is the most common oxidant used in water treatment. It is one of the most versatile and effective chemical oxidants. In addition to being a very effective disinfectant, its uses include the oxidation of iron & manganese, color removal, taste and odor control and as a flocculent aid. Unfortunately, chlorine also reacts with organics in the water to form potential carcinogenic by-products, especially when treating surface water**.**

6.3.2 Chlorine Dioxide is a powerful oxidant that is always prepared on site, usually by the reaction of chlorine and sodium chlorite. EPA presently recommends that the total residual (chlorite, chlorate, and chlorine dioxide) be no more than 1.0 mg/l. Chlorine dioxide is capable of:

- Oxidizing iron & manganese
- Removing color
- Lowing the THM formation potential.
- Oxidizing many organic and sulfurous compounds that produce off-taste and odor problems
- Adding a taste to the water that is objectionable to some.

Chlorine dioxide treatment does not produce THMs, and when chlorine results from the generation of chlorine dioxide, the formation of THMs are reduced.

6.3.3 **Ozone** is an unstable gas that must be generated on-site. Ozone is limited as an oxidant in that it dissipates rapidly in most natural waters and does not leave a residual. Compared to chlorine and chlorine dioxide, ozone appears to yield the smallest quantities of mutagenic by-products.

6.3.4 **Potassium Permanganate** is capable of oxidizing most organic compounds and inorganics such as iron & manganese. Potassium permanganate is used to oxidize:

- Iron & manganese
- Cyanide
- Phenols
- Certain taste and odor problems
- And used for color removal

The addition of potassium permanganate will produce pink water and could pass through to the distribution system if not controlled. Usually, potassium premaganate has done its job by the time it passes half way across the sedimentation basin and the pink color has disappeared.

7.0 PLANT SAFETY

Chemical storage and handling

7.1 Activated Carbon –

7.1.1 Smoking should be prohibited at all times whenever carbon is stored, handled, or unloaded.

7.1.2 The operator should wear proper respiratory protection whenever bags of carbon or bulk material are unloaded or otherwise handled. Avoid excessive dust and inhalation of carbon dust.

7.1.3 Carbon should be stored in a clean, dry place, in single or double rows, with access aisles around every stack for frequent inspection. This arrangement will augment easy removal of burning carbon in an emergency. Never store carbon in large stacks.

7.1.4 The storage area should be fireproof, with self-closing fire doors separating the carbon room from other sections. If a fire occurs be aware that carbon monoxide is a potential hazard.

7.1.5 Protective equipment (approved respirator, chemical goggles) should be worn by all operators handling carbon. It is also important to wear loose fitting, dust proof clothing, with collar closed and the ankles tied at the shoe tops.

7.1.6 Adequate shower facilities should be provided all personnel handling carbon.

7.2 Alum & Ferrous Sulfate

7.2.1 Employees should wear proper respiratory equipment and chemical goggles when handling or exposed to aluminum sulfate or ferrous sulfate dust. Both chemicals irritate the skin and mucous tissue because of their acid and anhydrous nature. Also, the dust can seriously injury the eye.

7.2.2 Chemicals should be stored in a clean dry place, because moisture can cause caking. When cleaning storage bins, hoppers, and other containers, observe the same precautions as when handling the chemical.

7.2.3 Operators should wear loose, denim-quality, dust proof, long sleeved clothing and a bandana and a cap. Tie trousers at the ankles and apply protective cream to exposed skin. An effective dust mask should be used.

7.2.4 Solution chemical pumps should be equipped with antisplatter shields around the stuffing box to protect personnel from leaks.

7.3 Lime

7.3.1 Operators exposed to quicklime dust should use chemical goggles and suitable respirators because lime is very irritating to the eyes, mucous membranes and upper respiratory tract, and can cause damage to the lungs after long exposure.

7.3.2 Store quicklime in a dry place where it is not exposed to moisture. This chemical has a great affinity for water, and a great deal of heat evolves when the two come into contact.

7.3.3 Contact with lime dust can cause dermatitis or skin burns, particularly at perspiration points. To protect the skin operators should wear heavy denim clothing with long sleeves, bandana, and trousers tied around the shoe tops.

Cover exposed skin with protective cream. Even if there is no dust, wear protective clothing in case a bag breaks.

7.3.4 Operators should always thoroughly shower immediately after handling quicklime.

Note: Hydrated lime has a less caustic reaction and therefore less irritating to the skin, but can seriously injure the eye. Dust respirators and chemical goggles should be worn.

7.4 Fluoride

7.4.1 Give all personnel handling fluorides detailed safety instruction. Avoid breathing fluoride dust, wash thoroughly after handling fluorides, and clean up spillage. Operators should wear respirators, chemical goggles, rubber gloves, and protective clothing when exposed to sodium fluoride or sodium silicofluoride dust and

7.4.2 Wear rubber boots and acid proof aprons when handling hydrofluoric, fluosilicic, and hydrofluosilicic acid.

7.4.3 An eyewash station and emergency shower should be located in the immediate vicinity of the fluoride chemical in case of acid splashes or sprays.

7.4.4 Fluoride chemicals should be stored in an area specifically designed for that purpose to avoid mistaken identity. Cover and vent all acid containers and store them where there is no fire hazard.

7.5 Soda Ash (Sodium Carbonate)

7.5.1 Soda Ash containers should be stored in a cool, dry place, not subject to moisture. Moisture causes caking and makes the chemical hard to handle.

7.5.2 If exposed to dusts and mists of soda ash, wear protective equipment including chemical safety goggles to protect the eyes, a close fitting dust respirator, and protective clothing to protect the skin. Cover exposed skin with a suitable cream or petroleum jelly. When handling soda ash solutions, wear goggles or face shield and rubber apron, gloves, and boots.

7.5.3 Pumps and equipment that handle soda ash solutions with suitable spray or splash blocks.

7.6 Potassium Permanganate

7.6.1 When handling this material, wear gloves, respirators eye protection, and protective clothing.

7.6.2 Store potassium permanganate in a closed container so that

7.6.3 It will never come into contact with organic or other material such as lubricants and carbon dust, ECT. as explosions may occur.

7.7 Chlorine

7.7.1 Electric chlorine detectors should be installed in the chlorinator room, the chlorine storage room, and the withdrawal room, with a sounding alarm and warning light. These devices should be checked often.

7.7.2 All operators should be provided with a self-contained, breathing apparatus (SCBA) or supplied-air respirators when making repairs.

7.7.3 All operators should be trained in the use of this equipment.

7.7.4 It is important that chlorine gas drills be conducted monthly to familiarize personnel with working while wearing the SCBA and using chlorine leak safety devices. Keep SCBAs, thick, loose-fitting gloves, and aprons or nonporous material in lockers outside the chlorine equipment area where they can be reached in an emergency.

7.7.5 Chlorine leak repair kits consisting of suitable clamps, drift pins, hammers, wrenches, and other tools should be kept on hand for emergency repairs.

7.7.6 Each chlorine room should have an adequate ventilating system designed to remove leaking gas. Because chlorine gas is heavier than air it will concentrate near the floor, locate the vents or grilles for removing contaminated air in the floor or scale pit or as near as possible to the floor. These vents should be near the center of the room or on the end of the room opposite the entrance. Air should exhaust through the roof or to a suitable outside area.

7.7.7 Switches to the ventilation system should be located outside the room where chlorine is used. Clearly mark them with large lettered signs and directional arrows.

7.7.8 The chlorine ventilation system should interact with the alarm system,

7.7.9 And be able to completely change the air in the room in 3 minutes.

7.7.10 When handling high-test hypochlorite (HTH), operators should wear gloves, aprons, dust respirators, goggles, and face shield.

7.7.11 HTH containers should be closed when not in use. Lubricants, oily rags, blood, or other organic material if dropped on an open container can cause an explosion or fire.

7.8 Sodium Chlorite

7.8.1 Sodium chlorite is a very strong oxidizing agent and is stable under most atmospheric conditions. The dry or moistening solid forms a dangerous explosive and combustible mixture with organic matter, such as, oil, grease, alcohol, aldehydes, wood, paper, and clothing. Avoid spillage on wooden floors. A deposit of small, finely divided crystals will form. Running a hand truck over the floor or scuffing of an operators shoe can cause ignition.

7.8.2 Clothing contaminated by chlorite should be washed with water. Do not allow the chemical to dry in the fibers. Locker fires have occurred because this precaution was not observed.

7.8.3 Operators should use SCBA or supplied air respirators to protect against chlorine dioxide gas.

7.9 Ozone

7.9.1 All operators exposed to ozone should use respiratory protection of the highest level possible. (SCBA or supplied air)

7.9.2 Operators should not be exposed to ozone levels above 0.10 ppm.

7.10 Carbon Dioxide

7.10.1 Keep the premises extremely clean and prohibit smoking whenever combustible gas is present.

7.10.2 Carbon dioxide generating equipment should be kept as close to the point of application as possible.

7.10.3 Carbon monoxide testers should be used before entering any carbonation basin.

7.11 Anhydrous Ammonia

7.11.1 Anhydrous Ammonia leaks are detected by holding an open bottle of hydrochloric acid or a cloth swab soaked with hydrochloric acid near the leak. This will generate a cloud of ammonia chloride near the leak.

7.11.2 Gaseous ammonia is lighter than air and rises; therefore, ensure that the ventilating system exhausts the air from the ceiling and bring in fresh air from the floor.

7.11.3 Gas masks approved for use against ammonia should be available for all operators, and

7.11.4 Should be located in easy reach of where leaks are expected.

7.11.5 Rubber or neoprene one-piece suits, sealed at the ankles, wrists, and around the face: SCBA or supplied-air respirators should be available to operators when working in high concentrations of ammonia.

7.11.6 Safety showers should be available to operators that provide at least 30-gpm capacity.

7.12 Ammonium Sulfate

7.12.1 Ammonium sulfate is not explosive by itself, but when mixed with quicklime or lime dust sufficient heat can be produced that could cause an explosion.

7.12.2 When handling ammonium sulfate, operators should use respiratory equipment and safety glasses.

8.0 Laboratory

8.1 General

8.1.1 All chemicals should be dated upon receipt and when initially opened. If a chemical has a shelf life, place the expiration date on the bottle and discard before that date.

8.1.2 It is a good practice to keep an inventory of all laboratory chemicals. A safe and healthy work place is the responsibility laboratory personnel. The OSHA "Hazard Communication Standard" or "Right to Know Regulations" specifies that exposed laboratory personnel have the right to know what hazardous materials are present, and the required procedures to protect themselves against these chemicals.

8.1.3 Chemical manufactures are required to provide Material Safety Data Sheets (MSDS). MSDS's should be kept in a three-ring notebook in the Laboratory to be read by all personnel. MSDS's should be updated periodically and revisited by all personnel. The contents of an MSDS are found in Attachment 5.

8.1.4 Recommended safety equipment is found in Attachment 6.

8.1.5 Prohibit eating, drinking and smoking in the laboratory.

8.1.6 Never store food for consumption in laboratory refrigerators or other equipment.

8.1.7 Never store acids and bases in the same area. When diluting acids always add the acid to the water.

8.1.8 Acids should be kept in an acid cabinet. If not available, store in the lowest shelf.

8.1.9 Bases such as ammonium hydroxide, sodium bicarbonate and calcium carbonate should be stored away from acids.

8.1.10 Store flammable liquids (acetone, alcohol, or ethers) in safety cabinets or an explosion proof refrigerators.

8.2 Laboratory equipment checklist – See Attachment #7.

8.3 Laboratory space

8.3.1 Adequate bench workspace is critical to the safety of employees.

8.3.2 Proper lighting is critical to the safety of employees.

8.3.3 Good housekeeping is indicative of how well you operate your lab and your plant. Keep your glassware, equipment, and counter top clean at all times.

8.3.4 An eyewash station should be located in the laboratory and checked monthly.

9.0 Water Quantity

9.1 A water treatment plant is normally described by its 24-hour plant capacity. This is the amount of water that the plant can safely produce in a 24-hour period and maintain compliance with the SDWA.

9.2 The safe yield is important for future planning. The safe yield of a well supply should be able to meet the present and future needs of the community it serves.

9.3 The Monthly Operating Reports (MOR's) should indicate the average daily water demand and

9.4 The maximum daily water demand.

9.5 If a system has a withdrawal permit from the state agency, it should know the amount it is allowed to withdraw, and the amount it is drawing now, so that a request for an additional amount can be requested in a timely manner.

10.0 Water Quality

10.1 **The Surface Water Treatment Rule** (SWTR) applies to surface water and ground water directly influenced by surface water. In these cases and where filtration is apart of the treatment train, continuous turbiditdometers are required to monitor each filter.

10.2 In addition, the SWTR requires that the confluence of all filters be monitored.

10.3 Continuous disinfectant residual recorders are required to monitor the plant effluent.

10.4 The SDWA of 1974 established the Primary Drinking Water Standards. See Attachment #8. The Primary Standards are enforceable by EPA and/or the State Primacy Agency

10.4.1 The plant should maintain a list of all Primary contaminates found in the drinking water and compare the results with the MCL for each.

10.4.2 A copy of the test results should be maintained at the plant and appear on the annual Consumer Confidence Report (CCR).

10.5 The SDWA of 1974 also established Secondary Drinking Water Standards that deal with the aesthetics of the water. (See Attachment #9) These standards are not enforceable by EPA, but each state is encouraged to adopt these standards.

10.5.1 A chemical analysis should be conducted of the secondary standards each year, with the

10.5.1 Test results maintained at the water plant and the main office.

10.6 **Microbiological sampling**.

10.6.1 The number of samples collected are determined by the population served. Each system should determine the number required and maintain records that indicate that they are in compliance.

10.6.2 Each system should develop a sampling plan and have it available on request.

10.7 **Lead and Copper Rule General –** Health effects: Lead ingestion effects the central nervous system, especially in children. Copper ingestion may cause gastrointestinal problems, chronic exposure effects the liver. The lead action level is 0.015 mg/l. The copper action level is 1.3 mg/l. The MCLG for lead is zero (0) mg/l and for copper, 1.3 mg/l. The basic requirements of the LCR are:

10.7.1 Lead service line replacement require

10.7.1.1 Systems to remove and replace all lead service lines owned by the utility.

10.7.1.2 Systems that replace only a part of a lead service line that they own, to notify residents of potential for temporary increases in lead levels and measures that can be take to reduce lead levels.

10.7.2 Demonstration of Optimal Corrosion Control

10.7.2.1 Systems must optimize corrosion control and continue to maintain and operate any corrosion control that is in place.

10.7.2.2 Systems that are deemed to be optimized because there is little or no corrosion occurring in their system

10.7.2.2.1 Monitor for lead and copper tap samples once every 3 years, and

10.7.2.2.2 Meet the copper action rule

10.7.3 Deliver education to the public

10.7.4 Monitor requirements

10.8 Ground Water Rule

11 Water Distribution and Cross Connection

11.1 All water supply systems should have an accurate distribution system map that show pipe size and material; valve size, location and whether right or left hand; blow-off locations; storage tank size, location and overflow elevation; Fire hydrant size, and location; booster pump location and rate of flow (GPM); and the location where all chemical and/or bacteriological samples are collected.

11.2 Many water utilities operate more than one pressure zone. Any time a booster pump delivers water to a higher storage tank a higher-pressure zone is created. It is very important that all boundary valves that isolate the zones be closed and shown on the distribution system map and clearly marked in the field. If these boundary valves are not closed, the high-pressure side will be pumped back into the low-pressure side and the pumps will run continuous and the tank will never fill. It is important to know the minimum, average and maximum pressure in each zone and check each of these periodically.

11.3 EPA and state agencies require that a minimum disinfectant residual be maintained in the distribution system at all times to protect against cross-connections and accidents that may occur. The minimum required is 0.20 mg/l free chlorine residual. Chlorine is used here because chlorine is the only disinfectant that will leave a measured residual.

11.4 Systems that cannot maintain at least 0.20 mg/l free chlorine residual may locate booster chlorine stations to boost the residual further down the line.
If so, these stations should be shown on the distribution system map and indicate whether gas chlorination or hypo chlorination is used.

11.5 All systems should have a written and active cross-connection prevention plan. All systems are vulnerable to the danger of cross-connections. First, make sure that there are no cross-connections in the water treatment plant that are not protected by a 6-inch air gap or a backflow prevention device. Next, target industrial users. Educate those employees in industry responsible for safety and industrial hygiene on the dangers of cross-connections in the plant and how toxic chemicals used in industrial processes may be vacuumed back into the plant’s drinking water and/or the utilities distribution system.

The utility may educate their customers through the CCR published each year. Weed killers and garden chemicals sprayed on plants through a garden hose may be vacuumed back into the customer's house and/or the utilities distribution system. It happens.

11.6 The "unaccounted for" water should be recorded each month on the Monthly Operating Report (MOR). "Unaccounted for" water is the difference between that produced at the plant and recorded by the plants master meter at the end of each month and the sum of all customer meters read that month. "Unaccounted for" water may be due to the different timing of the meter readings, fire flow that month (unmetered), water used in line flushing, customers that are not metered such as City Hall, fire stations and other city facilities, and last but not least … line leaks. In practice, 15% "unaccounted for" water is considered normal … three percent at the water plant and 10 to 12% for the distribution system. If you have more than that you may have a problem. Finding leaks and reducing the "unaccounted for" water can improve your financial status by reducing the expense of water treatment since most of the "unaccounted for" water is treated water that is not sold. .

11.7 Most small water utilities do not have a meter-testing program. It is suggested that it should be considered since replacing meters when they become slow will improve the revenue picture and be worth the investment.

11.8 All storage tanks should indicate volume, overflow elevation, whether it has cathodic protection, and whether it has telemetering equipment.

11.9 All booster pumps should indicate the manufacturer, type, horsepower, and Total Dynamic HeadTDH.

11.10 Distribution system operators should be certified by the regulatory authority.

12.0 Management

12.1 **Ownership –** The type of management of a water utility is based on ownership.

12.1.1 Privately owned utilities represent an individual, partnership, or corporate enterprise. Ownership is vested in a large number of stockholders, whose control is exercised through an elected board of directors.

12.1.2 Under publicly owned utilities, the voter is the ultimate owner, with management responsible to the public placed in the hands of a general manager. The organization may vary from a mayor-city council form where the mayor becomes the utility chief executive to the Utility Commission where the commission is appointed by the mayor-city council but operates independently.

12.2 **Organization –** Whenever two or more people are engaged in executing a task, the coordination of their individual tasks requires organization. Organization, then, is the means or process of coordinating the efforts of individuals in a common enterprise. Organizational planning is the development of a structure that will allow people to work together effectively. An organizational manual is an excellent way to insure that all employees have a clear understanding of their role in the overall scheme of things. The manual should include at least the following; 1 – A comprehensive organizational chart showing a breakdown of each major division and 2 – Job specification detailing the function, responsibility, objectives, limits of authority, and the relationship of each individual unit. There is a need for a periodic review to see that practice and understanding are in accordance with the plan. Adjustments in the plan may be needed to meet the changing requirements of the utility business.

In order for management to function properly it must be freed at every level of the burden of detail. This is done by delegating authority for final approval to others.

12.3 **Responsibility –** The primary purpose of a water utility has been to furnish potable water, that is, water that is drinkable from a physical, chemical and bacteriological standpoint and aesthetically acceptable to the public. With the introduction of the SDWA of 1974, utilities have been under a moral obligation to furnish water that is not only palatable, but also risk free (safe). Beyond the moral obligation there is a legal responsibility arising from federal, state, and local laws and regulations.

The responsibility of management as to the potability and safety of water can be resolved by the statement that management is expected to take every precaution that would be exercised by a normal, prudent individual who has a familiarity with the management of water systems. This would include a sanitary survey and a source water protection plan; proper supervision, including records and checks of the operation of the treatment works; a continuous evaluation of water demands for consumption and fire protection; and continuing investigation of residual pressures and disinfectants throughout the system and of the adequacy of pipe sizes from source of supply to the customers tap.

12.4 **Fire Protection –** The decision of whether to size distribution system components, including water mains, appurtenances, and storage facilities is made by the utility management and/or the city's governing body. Most municipal water utilities provide fire protection to their community. If so, it must be done in accordance with a well thought out plan. The Insurance Service Office (ISO) determines the fire protection rating system, in most states. The cost of insurance for fire protection is based on ISO's rating. The rating system ranges from 1 – 10 with 1 being the best rating. Management should be aware of this rating and determine whether there is anything that can be done to reduce the rating and the cost of insurance for their customers.

12.5 **Permits –** Utility management is responsible for obtaining all permits required in carrying out their duties to the public. These permits may include a withdrawal permit that limits the amount that can be withdrawn from the source; construction permits are usually required when ever improvements, additions, and/or expansions are made.

12.6 **Regulations** – Utility management must be in compliance with local, state, and federal regulations. These regulations, for the most part, are contained in the SDWA of 1974 and amendments of 86 & 96. Management must become familiar with these regulations and others that will be promulgated in future years.

12.7 **Water Rates –** One of the powers given to municipal utilities is the power to set service rates. This power is usually vested in the city governing body. Water and/or Sewer Boards that operate separate from the city governing body recommends rate increases to the city for their approval. In some states a Public Service Commission regulates water districts and some municipal utility rates.

It is the responsibility of utility management to maintain the proper records so that fair and timely rates can be maintained. For small water systems, these records may be non-existent. The records needed for a proper rate study fall in two main categories … revenue required and revenue available. Communities that operate water and sewer utility that combine revenue and expenses, should maintain separate records for water and sewer divisions. In order to conduct a fair and equitable study the following records should be maintained.

12.7.1 Revenue available

- **12.7.1.1** System sales
- **12.7.1.2** Penalties
- **12.7.1.3** Tap fees
- **12.7.1.4** Interest

12.7.2 Revenue required

- **12.7.2.1** Debt service – Principle and Interest on debt
- **12.7.2.2** Coverage on debt service
- **12.7.2.3** Operation and Maintenance
- **12.7.2.4** Capitalized improvements not debt financed.
- **12.7.2.5** Depreciation Schedule

Billing analysis – This is a study that tabulates annual bills by rate steps and indicates the number of customers and the consumption that fall into each rate block.

The goal in rating making is to set rates so that the revenue required equals the revenue available. If the revenue available is less that that required a rate increase is needed.

12.8 **Accounting –** The primary purpose of an accounting system is to (1) fulfill regulatory and legal requirements regarding record keeping and reporting; (2) provide for the recording and accumulation of financial data in a form that can be used effectively in the management of the utility; and (3) provide interested parties information sufficient to evaluate the financial condition of the utility. The National Association of Regulatory Utility Commissions (NARUC) has established a uniform system of accounts for water utilities based on gross revenue. Three important accounting reports that all managers should understand is the balance sheet, the income statement and the retained earnings.

12.9 **Office Operations –** Office operations can be improved by the use of a procedural manual. The purpose of a procedural manual is to develop the best way of accomplishing a given task.

12.10 **Engineering –** As stated earlier, management must provide a potable and safe water supply and proper pressures for domestic, commercial, industrial and fire protection. This element of utility management is the responsibility of the engineering staff. Many utilities are not large enough to have an engineering staff, and rely on professional engineering firms for this purpose. It is important to secure the services of competent consultants with knowledge and experience in the design, construction management, and operation of water utilities. Even when utilities have an in-house staff, it is often found advisable to retain an outside consultant for advice on particular problems or to provide an independent analysis for confirmation

12.11 **Standards –** The subject of engineering is directly related to specifications and standards. Management should be aware of the standards used in the water works industry. Standards used in the industry include AWWA Standards, American Society for Testing Material (ASTM), American Standards Association (ASA). Other standards that may be applicable include the American Concrete Institute and the American Institute of Steel construction. Every water utility should have a complete set of the AWWA Standards in their library.

12.12 Equipment Maintenance – Management should see that equipment is purchased under strict specifications, operated by qualified personnel, and properly maintained. Proper maintenance is preventative maintenance that is scheduled to prevent breakdowns. Management must state clearly its maintenance policy and actively support its position. Maintenance records and reports must be maintained to insure that equipment is properly maintained. These records can be accomplished by the use of two forms – one for preventative maintenance and the other for unscheduled or breakdown maintenance.

12.13 Insurance – Insurance is another means of protecting the equipment and facilities of the utility. Management should inform itself of the types and cost of insurance available to the utility. A good insurance program should include comprehensive coverage, property loss or damage, workmen's compensation, public liability, employee health insurance, and bonding of employees.

12.14 Personnel – Managers have a responsibility for establishing and maintaining good employee relations. Employees are the foundation of the organization. Managers must employ good; qualified people for each position, and provide a work environment that will bring out the best in people. It is important that the manager-supervisor understand the following basic principles of good personnel relations.

1. The best-qualified applicant should be selected without regard to race, color, creed, sex, or national origin.
2. Each employee, once employed, should be fully informed of his or her duties and responsibility of the position.
3. Employee records should be established and maintained in a systematic and uniform basis in conformance with federal law.
4. A wage and salary program should exist providing each employee with fair and equitable compensation compared to other positions within the utility and the local labor market.
5. All personnel policies and practices including work conditions, rules, and regulations should be in writing and available to all employees.
6. Each employee should be evaluated periodically by management on how the individual's work compares to the standard.
7. Employees should be informed of the organizational structures and the lines of progression so they can prepare themselves for promotion.
8. A formal method should be available to employees to discuss grievances and complaints with management.
9. Uniformity of treatment must exist for al employees regardless of race, color, creed, sex, age, or national origin.

12.15 In-service training – Today, with the introduction of the SDWA, in-service training is mandatory if they are to be up to date and in compliance with all of the new rules coming out each year. Management should provide direction on the type of training and place budgetary emphasis on training requirements. In-service training should be provided for water treatment, distribution, quality control, safety, and maintenance.

12.16 Safety Programs – Accidents are caused by unsafe acts of employees or from hazardous conditions. The prevention of accidents begins with the education and training of employees in safe work practices and procedures and creating and maintaining the proper attitude toward safety by all employees from the top management to the person in the ditch.

A successful program should include

1. Management leadership
2. Assignment of responsibility
3. Maintenance of safe working conditions
4. Establishment of safety training
5. An accident record system
6. Medical and first aid system
7. Acceptance of personal responsibility by each employee.
8. Conduct safety meeting with employees periodically.

12.17 Public Relations – Knowing that you and your utility do a good job is not enough. You must tell the public. EPA's CCR requirement has forced the issue on all utilities to inform the customer. This is only the tip of the ice burg. Public relations begin with the employees. Informed employees reflect the competence of any organization or manager. Get involved with the local civic leaders and the Chamber of Commerce. Let them know the utility's ability to serve when seeking new industry.

12.18 Annual Reports - EPA's Consumer Confidence Report (CCR) requirement contained in the 1996 Amendments to the SDWA has solved the question of annual reports. In addition to the requirements of the CCR, financial data may also be of interest. Financial results should be clearly shown. These should include a yearly income statement and balance sheet. A good report would show the meaning of balance sheet items.

12.19 Employee Handbook – The Employee Handbook serves to orient the employee to the standards of employment. Information shown in an employee handbook could include such things as; pay, hours of work, holidays, vacations, sick leave, absences, insurance, hospitalization and medical plans, pensions, and other special programs and opportunities. Other miscellaneous items to include in an employee handbook follows; grievance procedure, safety program, Civil Rights rules, personal use of telephone, smoking at work, use of company cars, use of personal cars on company business, conduct and appearance, and others to numerous to list.

References used in the preparation of this document.

Section I – Purpose

Training Manual for Water Plant Operators, Commonwealth of Kentucky, Department for Natural Resources and Environmental Protection Bureau of Environmental Quality, Division of Sanitary Engineering, Frankfort, Kentucky.

Section 2 - Source Water (Wellhead) Protection
Training Manual for Water Plant Operators, Commonwealth of Kentucky, Department for Natural Resources and Environmental Protection Bureau of Environmental Quality, Division of Sanitary Engineering, Frankfort, Kentucky
Ground Water Manual for Small Water Systems, Drinking Water Assistance Program, The Montana Water Center, Montana State University, in cooperation with the Montana Department of Environmental Quality.
Section 3 – Ground Water General Information
Recommended Standards for Water Works, Great Lakes Upper Mississippi River Board of State Public Health & Environmental Managers, 1992.
Small Water System Operation and Maintenance, Fourth Addition, California Department of Health Services, Sanitary Engineering Branch, US Environmental Protection Agency, Office of Drinking Water
Section 4 – General Well Construction
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Integrated Design And Operation of Water Treatment Facilities, Second Edition, Susumu Kawamura, John Wiley & Sons, Inc.
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Water Quality and Treatment, Fourth Addition, AWWA, A Handbook of Community Water Supplies
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Training Manual for Water Plant Operators, Commonwealth of Kentucky, Department for Natural Resources and Environmental Protection Bureau of Environmental Quality, Division of Sanitary Engineering, Frankfort, Kentucky
Water Quality and Treatment, Fourth Addition, AWWA, A Handbook of Community Water Supplies
Section 7 – Plant Safety
Safety Practice for Water Utilities, Manual of water supply Practice, AWWA M3
Section 8 - Laboratory
A Practical Laboratory Manual, Volume 1, KY/TN AWWA Water Quality Committee, 1998.
Section 9 – Water Quantity
Training Manual for Water Plant Operators, Commonwealth of Kentucky, Department for Natural Resources and Environmental Protection Bureau of Environmental Quality, Division of Sanitary Engineering, Frankfort, Kentucky
Section 10 – Water Quality
New Dimensions in Safe Drinking Water - AWWA
Section 11 – Water Distribution and Cross Connection
Distribution System Requirements for Fire Protection, Manual of Water Supply Practices, AWWA M31.
Section 12 - Management
Water Utility Management, Manual of Water Supply Practice, AWWA M5
AWWA Journal – January 2000 – Management in the 21st Century

ATTACHMENT #1
CONSUMER CONFIDENCE REPORTS
(CCR)

A. Who? Community Water Systems (CWS)

B. When?

- **First Report was due October 19,1999**
- Second report: July 1,2000
- Subsequently: July 1 annually
- Certification: 90 days after report
- A new CWS: July 1 of the year after the first year of operation.

For systems that sell wholesale

- Provided information to wholesaler by April 19,1999 the first year
- Subsequent years by April 1, or by contract.

C. How?

1 CWS population >= 10,000
- Mail only

2 CWS population < 10,000 (Exemptions)
- Publish in one or more local newspaper
- Inform customers that reports are not going to be mailed
- Make reports available on request

3 CWS population <= 500 (Exemptions)
- Notice by mail or
- Door to door delivery or
- Post that report is available on request

4 Good faith effort to notify non bill-paying customers

5 Governor makes determination

D. Consumer Confidence Report must include

- Source information
  - Type of water source (surface, ground or both)
  - Common name of source and location
  - If Source Water Assessment is complete, provide location of copy
- Definitions (Plainly worded)
  - MCL, MCLG, Action Level, Treatment Technique
  - If under a variance or exception, must define
- Levels of regulated contaminants:
  - MCL, MCLG, Action Levels, or Treatment Technique
  - Highest detected level and range of detected levels
  - Likely sources of contaminants
  - Health effects of any MCL violated using mandatory language.

- Level on Unregulated Contaminants- Average and range
- *Cryptosporidium* and Radon
  - **Presence in source or finished water**
  - Summary and significance.
- Additional contaminants

E. Educational information for Arsenic, Lead, and Lead

- Arsenic must be covered if detected at 50% of the MCL
- Nitrate must be covered if detected at 50% of the MCL
- Lead must be covered if detected above the Action Level in more than 5% of the homes sampled.

F. Other violations & information that must be included

- Monitoring & Reporting
- Treatment Technique
- Record keeping
- Special monitoring requirements
- Violation of a variance, exemption, or agreed order

G. Mandatory Language required by the EPA Rule

- Standard paragraphs discussing sources of drinking water and contaminants
- Explanations of contaminants in drinking water, including bottled water
- Risk statement
- EPA hotline number. 1-800-426-4791
- Additional health effects information

References:
Kentucky Division of Water
Tennessee Division of Water Quality

ATTACHMENT #2
STAGE 1
Disinfection/Disinfectant Byproduct Rule (D/DBP 1)

A. Compliance Dates for D/DBP 1 Rule

- Community and non-transient non-community water systems
  - Effective date – January 2002
    - Population served >= 10,000
    - Raw water sources: surface water and ground water under direct influence of surface water
  - Effective date – January 2004
    - Population served <= 10,000
    - Raw water sources: Surface water and ground water under the direct influence of surface water.
    - All Ground Water not under the direct influence of surface water.

B. D/DBP 1 Monitoring Plan

- Must make available within 30 days of effective date of rule
- Systems serving population > 3,300 must submit plan to state for review
- Provide sample locations
- Must reflect entire distribution system
- Include how system will calculate compliance with MCLs, MRDLs and treatment techniques.

C. D/DBP 1 New Definitions

- (MRDL) Maximum Residual Disinfectant Level – Level of a disinfectant added for water treatment that may not be exceeded at the consumers tap without an unacceptable possibility of adverse health effects.

D. D/DBP 1 New Standards

- New MCLs:
  - Trihalomethanes (TTHMs) – 0.080 mg/l
  - Holoacetic acids (HAA5) – 0.060mg/l
  - Bromate – 0.010 mg/l)Ozone)
  - Chlorite – 1.0 mg/l (Chlorine Dioxide)
- New MRDLs:
  - Chlorine and chloramine – 4.0 mg/l
  - Chlorine Dioxide – 0.8 mg/l

E. New Contaminants

- Haloacetic acids (five) HAA5
  - Dibromoacetic acid
  - Dichloroacetic acid
  - Monobromoacetic acid
  - Monochloroacetic acid
  - Trichloroacetic acid

F. TTHMs (0.080 mg/l) – HAA5 (0.060 mg/l)

- Surface Water and Ground Water Under the Influence
  - Routine
    - Population >= 10,000 4/plant /quarter
    - Population 500 – 9,999 1/plant/quarter
      Maximum Residence Time
    - Population < 500 1/plant/year
      During month of warmest water temperature
      Maximum Residence Time
    - MCL compliance determined quarterly on running annual average

Required Removal of TOC

	Alkalinity (as $CaCO_3$)		
Raw TOC mg/l	**0-60** mg/l	**60-120** mg/l	**>120** mg/l
2-4	35%	25%	15%
4-8	45%	35%	25%
>8	50%	40%	30%

References:
Kentucky Division of Water
Tennessee Division of Water Quality

ATTACHMENT 3
INTERIM ENHANCED SURFACE WATER TREATMENT RULE (IESWTR) EFFECTIVE JANUARY 2002

A. General

- Applies to public water supplies using surface water and ground water under the direct influence of surface water, serving a population >= 10,000.
- Provides guidance in the use of oxidants other than chlorine
- Filtration requirements for the 2 log removal of *Cryptosporidium*
- Requires a more comprehensive sanitary survey – Must respond to deficiencies in 45 days.
  - Community water supplies every 3 years
  - Non-community water supplies every 5 years

B. Sanitary Survey Components

- Source
- Treatment processes
- Distribution System
- Finished water storage
- Pumps, pump facilities, and controls
- Monitoring reporting and data verification
- Systems management and operation
- Operator compliance with state requirements

C. Treatment Techniques

- Alternative filtration technology, with disinfection must achieve removal and/or inactivation of:
  - *Cryptosporidium* oocysts 99% 2 log
  - *Giardia lamblia* cysts 99.9% 3 log
  - Viruses 99.99% 4log
- State sets performance standards:
  - Must meet treatment technique removal/inactivation requirement 95% of the time
  - Must not exceed at any time.

References:
Kentucky Division of Water
Tennessee Division of Water Quality

ATTACHMENT 4
CT VALUE AND EXAMPLE CALCULATIONS

INTRODUCTIONN: The CT calculations involve a two step process. First, the log removal step is accomplished by complete treatment. The second, the log inactivation step, is accomplished by disinfection. If your plant provides complete treatment your plant may qualify for log removal credits.

LOG REMOVAL - Kentucky and other states may grant a maximum 2 log removal credit for Giardia and Viruses provided you meet all of the following criteria.

1. Disinfect at or prior to the flash (rapid) mix.
2. Turbidity of the settled water (prior to filtration) is less than 2 NTU's measured every four hours.
3. The turbidity level of a system's combined filtered water at each plant must be less than or equal to 0.3 NTU in at least 95% of the measurements taken each month, and the turbidity level of a system combined filtered water at each plant must at no time exceed 1 NTU.
4. All equipment must be in working order.
5. Operators must be properly certified for the size of plant and be properly staffed.

After you have submitted your information to the state, the state will determine your log removal credit. The remaining log inactivation is the difference between the SWTR goal and the removal credit and must be accomplished by disinfection up to the first customer. Keep in mind that the first customer may be the water plant itself. If the water plant is not the first customer, arrangements should be made so that it is. This makes the CT calculations easier and less complicated.

LOG-ACTIVATION – The CT values found in the EPA Tables (CT VALUES FOR INACTIVATION OF GIARDIA AND VIRUSES) were developed through research. The disinfectants used in the EPA tables include free chlorine, chloramine, chlorine dioxide, ozone, and ultraviolet light. Chlorine will not inactivate Cryptosporidium. Therefore, Cryptosporidium must be eliminated by the log removal step. The CT value is calculated from the following formula.

- CT = Disinfectant concentration (mg/l) x Contact time (Min.) x Baffling factor
- The contact time is the time in minutes that the disinfectant stays in contact with the water through a specific unit or zone in your system.
- The baffling factor is applied to the unit based on the design.

BAFFLING FACTOR – There are two methods used in determining the contact time through a treatment unit. These methods are the theoretical method (Volume/Flow) and by tracer studies. The theoretical method is based on baffling factors and is the method most often used. Tracer studies require more time, manpower, money, and equipment to perform and are used less frequently. EPA has listed three classifications of baffling (poor, average and superior) that fit in between no baffling and perfect baffling (plug flow). See Table 1.The SWTR defines contact time as the time it takes for 10% of the water entering a basin through the inlet to pass through the outlet. The theoretical time is known as T_{10}.

Factors that influence contact time include:

1. Flow rate
2. Water level in the unit

3. Shape of the unit
4. Inlet/outlet locations
5. Baffle types and locations
6. Whether the unit is filling or emptying
7. Sludge depth
8. Seasonal variations, and
9. Thermal stratification

Based on various tracer studies, the STWR introduces three classifications and baffling factors in addition to the unbaffled and the perfect flow (plug flow).

TABLE 1 BAFFLING CLASSIFICATIONS

CONDITION	FACTOR	DESCRIPTION
Unbaffled Mixed flow	0.1	None, agitated basin, very low length to width ratio, high inlet and outlet velocities.
Poor	0.3	Single or multiple unbaffled inlets and outlets, no intra-basin baffles
Average	0.5	Baffled inlet or outlet with some intra-basin baffles.
Superior	0.7	Perforated inlet baffle, serpentine or perforated intra-basin baffles, outlet weir, or perforated launders.
Perfect Plug flow	1.0	Very high length to width ratio (pipeline flow), perforated inlet, outlet, and intra-basin baffles.

The contact time can often be improved by baffling the unit, redesigning the inlet/outlet, or changing existing baffling.

CALCULATION OF CT VALUES

The information you need:

1. Peak flow (GPM) of Raw & Finished water. If they are different, use the appropriate rate in each instance.
2. Water temperature in Centigrade.
3. pH
4. Disinfectant residual (mg/l)
5. Capacity (Volume in gallons) of all retention basins
6. A schematic or flow chart of your system
7. Operating clearwell level for the day
8. Note the sludge depth in any unit, such as the sedimentation basin, and subtract that amount from the calculated volume.

EXAMPLE CALCULATIONS:

GIVEN INFORMATION:

Water source – a river intake one mile (5,280 feet) from your water plant. Water is delivered to the plant through an 8-inch water main.
Raw water pumps deliver the water to the plant at 700 GPM.
The pH is 8.0
The water temperature is 0.5^{0} C or 32.9^{0} F.

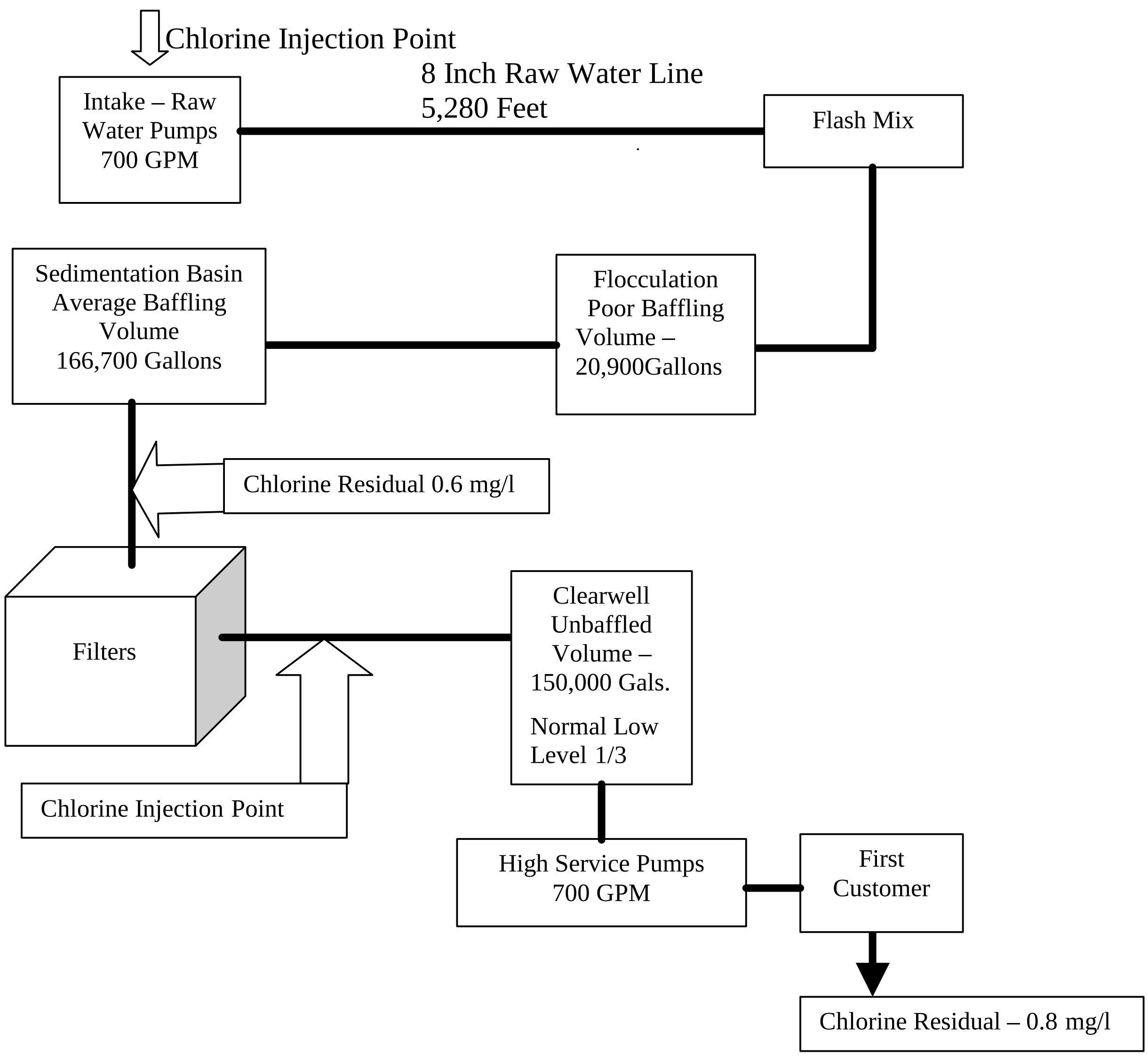
The water treatment plant uses complete treatment and is assigned the maximum 2-log removal credit.
The chlorine gas is injected at the intake and again at the filter effluent.
The free chlorine residual is measured as:

0.6 mg/l at the filter influent … and

as 0.8 mg/l after the clearwell (Plant tap – the first customer)
The high service pumps deliver the water to the system at 700 GPM.
The water treatment plant is the first customer.

CT PROCEDURAL STEPS

1. Draw schematic
2. Label schematic.



3. Determine the Log-inactivation CT Value required for your system.
   a. Determine the Log-removal credits for your system
   b. Subtract the Log-removal credit from the STWR goal. This is the Log-inactivation goal that must be met by disinfection.

PATHOGEN/STRW GOAL	**- REMOVAL CREDITS**	**= INACTIVATION**
Giardia cycts/3 log	- 2 log	= 1 log
Viruses/ 4 log	- 2 log	= 2 log

4. Calculate the volume and detention time of each basin.

Note: You can only use the volumes of basins after the first injection point of disinfectant and up to the first customer. The first volume to consider is the 8-Inch raw water main.

a. 8-Inch Transmission Main

Volume = $(\pi D^2/ 4) L$
Where:
π is the constant pi (3.14)
D is the diameter in feet
L is the length in feet.
Volume = $\{(3.14)(8/12)^2 / 4\}ft^2$ x 5,280 ft
Volume = 1,843 ft^3
Convert to Gallons – Where 1 ft^3 = 7.48 Gallons
Volume = 1,843 ft^3 x 7.48 Gals/ft^3
Volume = 13,786 Gallons
DT = Volume/Flow x Baffling Factor (BF) - BF = 1 for pipe line or plug flow
DT = (13,786 Gallons/700 GPM) x 1.0 = 19.69 Minutes

b. **Flash Mix –** Even though the detention time of this unit is less than one minute and therefore not a factor in calculating the CT, it should be known. You obtain the dimensions of the rapid mix from the “as built” or “record” drawings provided by the consultant or measure the length, width, and water depth of the rapid mix. For this example the measurements are 4 feet 6 inches square and the water depth is also 4 feet 6 inches. The volume of the rapid mix is therefore:

Volume = (L) (W)(D)
Where: L = Length
W = Width
D = Depth
Volume = (4.5ft)(4.5ft)(4.5) = 91.125 ft^3
Volume in Gallons = 91.125 ft^3 x 7.48 Gallons/ft^3
Volume = 681.62 Gallons
(Theoretical) Detention Time (DT) = Volume (V)/Rate (R)
DT = 681.62 Gallons/700 GPM
DT = .97 minutes This is OK since it is less than one minute.

c. **Flocculator**: The theoretical detention time for the flocculator is calculated the same way i.e. Volume / Flow. In this example the length to width ratio is 2:1 with a depth of 10 feet. The dimensions of the flocculator are:

L = 29.0 feet
W = 14.5 feet
D = 10.0 feet
V = (29 ft)(14.5ft)(10ft) = 4205 ft^3
Volume in Gallons = (4205 ft^3)(7.48 Gals/ft^3) = 31,453 Gallons
Theoretical DT = 31,453 Gallons/700 GPM = 44.93 Minutes (OK)

The baffling of the flocculator is determined to be poor. The factor is 0.30. The detention time used to calculate the CT is:
DT = 44.93 minutes x 0.30 = 13.47 minutes
As you can see the baffling factor plays a major roll in compliance with the IESWTR.

d. **Sedimentation Basin**: This is a conventional sedimentation basin and is also designed around a length to width ratio of 2:1 and a theoretical detention time of 4 hours. The dimensions are:

L = 61 feet
W = 30.75 feet
D = 12 Feet
V = (61ft)(30.75ft))(12ft) = 22,509 ft^3
Volume in Gallons = (22,509 ft^3)(7.48 Gals/ft^3) = 168,367 Gallons
Theoretical DT = 168,367 Gals/700 GPM = 240.52 Minutes (OK)

The baffling factor as been determined to be average or a factor of .5.
The detention time for this sedimentation basin used in the CT calculation is 240.52 Minutes. x .5 = 120.26 Minutes.

e. **Filter**: The volume of the filter is not a factor in these calculations since the time through the unit is insignificant. However, if you wish to include the filter, measure the disinfectant residual at the filter effluent, plug flow is assumed through the filter.

f. **Clearwell**: The clearwell volume is designed to be 15% of the 24 hour plant capacity of 1,000,000 Gallons Per Day (GPD) or 1,000,000 gallons x .15 = 150,000 gallons. Since the flow rate is 700 GPM the theoretical DT is 150,000 Gallons/ 700 GPM = 214.26 Mins. This would be more than adequate for this plant if the clearwell was properly baffled and operated full. However, in this example the clearwell is unbaffled and operates only 1/3 full. This reduces the detention time used in the CT calculations to (214.26 Minutes.)(.1)(.34) = 7.28 minutes. By baffling this clearwell or operating the basin full or both, the detention time would be greatly improve. This would provide more contact time for the disinfectant to inactivate giardia and viruses.

5. Calculate the CT Value of each basin
   Transmission Main CT = 0.6 mg/l x 19.69 minutes = 11.81 mg/l.mins
   Flocculator CT = 0.6 mg/l x 13.47 minutes = 8.08 mg/l.mins
   Sedimentation CT = 0.6 mg/l x 120.26 minutes = 72.15 mg/l.mins
   Clearwell CT = 0.8 mg/l x 7.28 Minutes = 5.82 mg/l.mins

6. Look up the required 1-Log CT Value in Appendix A for Giardia Cysts. When using a free chlorine residual, if you can meet the CT required for Giardia you meet the CT for all other pathogens. This is because Giardia is more resistant to Free Chlorine and requires a greater CT Value than viruses.
   Transmission Main - pH 8, Temp. 0.5^0 C, Free Residual = 0.6 mg/l
   Transmission Main CT Value = 95 mg/l.mins
   Flocculator - pH 8, Temp. 0.5^0 C, Free Residual = 0.6 mg/l
   Flocculator CT Value = 95 mg/l.mins
   Sedimentation - pH 8, Temp. 0.5^0 C, Free Residual = .6 mg/l
   Sedimentation CT Value = 95 mg/l.mins
   Clearwell - pH 8, Temp. 0.5^0 C, Free Residual = .8 mg/l
   Clearwell CT Value = 98 mg/l.mins

7. Calculate the Log inactivation ratio for each unit. This is determined by dividing the CT Calculated by the CT Required.
   Transmission Main:
   Log Inactivation Ratio = 11.81 mg/l.mins /95 mg/l.mins = .1243
   Flocculator:
   Log Inactivation Ratio = 8.08 mg/l.mins / 95 mg/l.mins = .0850
   Sedimentation Basin:
   Log Inactivation Ratio = 72.15 mg/l.mins / 95 mg/l.mins = .7595
   Clearwell:
   Log Inactivation Ratio = 5.82 mg/l.mins / 98 mg/l.mins = .0594
   Total Log Inactivation Ratio = 1.0282

Since the total Log Inactivation Ratio is 1.0 or more, it is assumed that this water plant is in compliance with the SWTR treatment technique.

References:

1. Training Manual for Water Plant Operators, Commonwealth of Kentucky, Department Of Natural Resources and Environmental Protection, Bureau of Environmental Quality, Division of Sanitary Engineering
2. Manual of Instruction for Water Plant Operators. New York State Department of Health.
3. Surface Water Treatment: The New Rules, Harry Von Huben, AWWA
4. CT Values Calculations and Reporting, Donna Marlin EIT, Drinking Water Branch, Division of Water, March 24, 1999.

ATTACHMENT #5 – CONTENTS OF A MATERIAL SAFETY DATA SHEETS (MSDS)

Section 1: General Information

Product, Manufacturer, and Telephone #
Chemical Name, Trade, Name, and synonyms
Chemical Family, CAS #, Formula
Prepared By, Date
Hazardous Mixture Ingredients, Percent of Each, TLV Unit

Section 2: Physical Data

Specific Gravity, Boiling Point, Vapor Pressure
Density, Solubility, Appearance and Odor
Freezing Point, % Volatile, Evaporation Rate

Section 3: Fire and Explosion Data:

Flashpoint (Method), Flammable Limits, LEL, UEL
Extinguishing Media, Special Fire Fighting Procedures, Unusual Hazards

Section 4: Reactivity and Stability

Stability, Hazardous Decomposition Products
Materials to Avoid

Section 5: Protection Information

Ventilation, Respiratory, Other Protective Equipment
Protective Gloves, Eye Protection
Other Protective Equipment

Section 6: Healthy Hazard Data:

Threshold Limit Value, Effects of Overexposure
Emergency & First Aid Procedures: Ingestion, Skin, Inhalation, and Eyes

Section 7: Spill or Leak Procedures

Precautions to be taken in handling and storage, other precautions
Waste Disposal

Section 8: Special Precautions and Use Directions

Section 9: NFPA Hazard Rating

Section 10: Regulatory Information – (DOT Info, SARA Info)

References:

***A Practical Laboratory Manual* –** Volume 1, KY-TN AWWA Water Quality Committee, 1998.

ATTACHMENT #6 RECOMMENDED SAFETY EQUIPMENT

- Fire Extinguishers: Three general types
- Water type
- Dry chemical type
- Carbon dioxide type
- Fire Blankets
- Safety Showers – test frequently (Monthly at a minimum)
- Eye washes – test frequently (monthly at a minimum)
- Laminar Flow Hood – for handling volatile, flammable, odorous chemicals, and fine particles
- Chemical Spill Kits: for handling alkalis, acids, and solvents
- Storage Facilities:
  - Store flammable chemicals in properly vented cabinets approved by the National Fire Protection Association.
  - Store dissimilar chemicals separately
  - As a general rule, do not store large containers or regents in working areas, but use smaller containers holding only enough for the day's or weeks work.
- Personal Protective Equipment
  - Goggles or safety glasses
  - Gloves (some chemicals require special type gloves)
  - Plastic apron
  - Safety shoes, preferably leather that covers entire foot, no open toed shoes or sandals
  - Respirator
- Safety wall chart: containing information on hazardous laboratory substances.

References:

***A Practical Laboratory Manual* –** Volume 1, KY-TN AWWA Water Quality Committee, 1998.

ATTACHMENT #7: LABORATORY CHECK LIST

Buret clamp, double	1
Buret, Nalgene automatic self zeroing With teflon stopcock and reservoir Class B 50, 25, and 10 ml	3
(Option – Digital Buret)	1 for each titrant used
Funnels (recommend several sizes)	3
Brush, beaker/flask, heavy duty, wooden handle	2
Brush, beaker, 22 mm x 140 mm, 91 cm long	4
Spatula/spoon (wooden tongue depressors can be used)	2
Thermometer, -20 to 110^{o}C, total immersion general Purpose (alcohol filled recommended)	2
Weigh papers or boats	1 pack
Tongs, stainless steel	1
Analytical Balance capable of weighing to 0.001 grams	1
Magnetic stir plate	1
Hot plate	1
Option – stirring hot plate	1
Timer, capable of timing minutes and seconds	1
Sample bottles, chemical	5
Wash bottles	2
Heavy duty beakers, 1000, 500, 250, 100, and 50 ml	2 each
Beakers, polypropylene, 1000, 500, 250, 100 and 50 ml	2 each
Graduate cylinder, 100, 50, and 25 ml	2 each
Disposal serological pipets (variety 1 – 25 ml)	variety
Disposal transfer pipets 1 – 10 ml	1 pack each
Erlenmeyer flask, 250 ml, 500, 1000 ml	3 each
Volumetric flask, 1000, 500, 100 ml	2 each
Buret stand	1
Stir rods (plastic)	4
Crucibles	4
Kimwipes or lint free wipes	10 boxes
Sharpie markers or other permanent marker	2
Spectrophotometer 1 cm cells (a combination of quartz and disposal	12
Spectrophotometer	1
Turbidity cells	6
Stir bars (if using magnet stir or hot plate)	6
Volumetric Cylinders, 100, 250, 500 mls	1 each
Graduate mixing cylinder with stopper	2
Stir bar retriever	1

References:

A Practical Laboratory Manual **–** Volume 1, KY-TN AWWA Water Quality Committee, 1998.

ATTACHMENT #8 – USEPA PRIMARY STANDARDS

Inorganic Chemical	MCL	
Arsenic	0.05 mg/l	
Asbestos	7 million fibers (longer than 10 microns)	
Barium	2.0 mg/l	
Cadmium	0.005 mg/l	
Chromium	0.10 mg/l	
Fluoride	4.0	mg/l
Mercury	0.002	mg/l
Nitrate	10.0 (as N)	mg/l
Nitrite	1.0 (as N)	mg/l
Total nitrate as nitrite	10.0 (as N)	mg/l
Selenium	0.05	mg/l
Antimony (Total)	0.006	mg/l
Beryllium (Total)	0.004	mg/l
Cyanide	0.20	mg/l
Nickel	0.10	mg/l
Thallium (Total)	0.002	mg/l

Organics		
Endrin	0.002	mg/l
Alachlor	0.002	mg/l
Altrazine	0.003	mg/l
Carbofuran	0.04	mg/l
Dibromodichloropropane	0.0002	mg/l
2,4 Dichlorphenoxyacetic acid	0.07	mg/l
Ethylene dibromide	0.00005	mg/l
Heptachlor	0.0004	mg/l
Heptachlor	0.0004	mg/l
Heptachlor expoide	0.0002	mg/l
Chlordane	0.002	mg/l
Lindane	0.0002	mg/l
Methoxychlor	0.04	mg/l
Polychlorinated biphenyls	0.0005	mg/l
Toxaphene	0.003	mg/l
2,4,5 Trichlorophenoxyproprionic	0.05	mg/l
Aldicarb	0.003	mg/l
Aldcarb Sulfoxide	0.004	mg/l
Aldicarb Sulfone	0.002	mg/l
Pentachlorophenol	0.001	mg/l
Dinoseb	0.007	mg/l
Hexachchlorobenzene	0.001	mg/l
Oxamyl	0.2	mg/l
Picloram	0.5	mg/l
Hexachlorocyclopentadiene	0.05	mg/l

Simazine	0.004	mg/l
Dalapon	0.2	mg/l
Benzo (a)pyrene	0.0002	mg/l
Di (2-ethylhexyl)apidate	0.4	mg/l
Di (2-ethylhexyl)phthalate	0.006	mg/l
Endothall	0.1	mg/l
2,3,7,8 – TCDD Dioxin	0.00000008	mg/l

Combined radium – 226 and radium – 228: 5 pCi/l

Gross alpha particles activity (including radium – 226 but excluding radon and uranium: 15 pCi/l

Gross Beta	50	pCi/l
Strontium-90	8	pCi/l
Tritium	20,000	pCi/l

Reference:
USEPA

ATTACHMENT #9- SECONDARY STANDARDS

Chloride	250	mg/l
Color	15	color units
MBAS (Methyl Blue Active Substance)	0.5	mg/l
Iron	0.3	mg/l
Manganese	0.05	mg/l
Odor	3	mg/l
pH	6.8-8.5	
Sulfate	250	mg/l
TDS (Total Solids)	500	mg/l
Zinc	5	mg/l
Fluoride	2.0	mg/l
Aluminum	0.2	mg/l
Silver	0.1	mg/l

Action levels

Lead	0.015	mg/l
Copper	1.3	mg/l

Reference:

USEPA