Sanitary Survey Field Reference

EPA

For Use When Conducting a Sanitary Survey of a Small Water System

Office of Water (4606M)
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Disclaimer

The Drinking Water Protection Division of the U.S. Environmental Protection Agency (EPA) Office of Ground Water and Drinking Water has reviewed and approved this document for publication. This document provides guidance to personnel conducting sanitary surveys and contains several recommended questions. This guide uses the terms “sanitary survey” and “surveyor” exclusively to avoid any confusion due to multiple definitions of other terms. The term “state” where used in this document includes EPA where EPA is the Safe Drinking Water Act (SDWA) primacy agency and where applicable.

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This document is not intended to be comprehensive and other approaches may be appropriate for conducting sanitary surveys and satisfying the requirements of the National Primary Drinking Water Regulations (NPDWR) for sanitary surveys. While EPA has made every effort to ensure the accuracy of the discussion in this document, the obligations of the regulated community are determined by statutes, regulations or other legally binding requirements. In the event of a conflict between the discussion in this document and any statute or regulation, this document would not be controlling.

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1 Introduction

The purpose of a sanitary survey is to review a public water system (PWS) source, facilities, equipment, operation and maintenance to evaluate the adequacy of these elements for producing and distributing safe drinking water. These elements provide multiple barriers for the protection of public water supplies.

A sanitary survey serves as an important and proactive public health measure, identifying areas that need additional attention and resources or improved performance by the PWS to ensure continuing compliance with the NPDWR as well as state regulations and requirements. The on-site sanitary survey also serves to maintain continuing communication between the PWS and the State and provides an opportunity to inform PWS personnel of new regulations or

requirements, training opportunities and other available resources and, if appropriate, provide technical assistance.

A sanitary survey must include the following eight essential elements (40 CFR 142.16):

1. Water source (protection, physical components, and condition)
2. Water treatment
3. Distribution system
4. Finished water storage
5. Pumps, pumping facilities, and controls
6. Monitoring, reporting, and data verification
7. Water system management and operation
8. Operator compliance with state requirements

2 How to Use This Guide

This field guide is designed as a companion document to EPA's *How to Conduct a Sanitary Survey of Drinking Water Systems: A Learner's Guide*. Key illustrations and pictures from the EPA's Learner's Guide, along with the most relevant questions are included in this field guide. The field guide can be used to remind the surveyor of key components and questions for each of the sanitary survey elements. It can also be used to show operators key components that may be an issue.

This field guide references the voluntary consensus standards for PWSs by the Water Supply Committee of the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, "Recommended Standards for Water Works, 2018 Edition" commonly referred to as the "Ten States Standards." This field guide also references industry

standards of the American National Standards Institute (ANSI), NSF International (NSF), and the American Water Works Association (AWWA). These references are provided for information only. Any state regulations, standards, policies, and recommendations would be applicable to PWSs in those states.

3 Ground Water Sources

3.1 Quantity

- Is the safe yield sufficient to meet current and future demands?
- Is the quantity of the source sustainable?
- Does the PWS have an operational master meter?
- How many service connections are there? Does the PWS meter all service connections?
- Does the PWS have interconnections with neighboring PWSs or a contingency plan for water outages?
- Does the PWS have redundant sources?

3.2 Quality

- Does the PWS have a smooth-nozzle raw water tap and treated water tap for each well?
- Are there any abandoned wells and have they been properly closed?
- Are there unused or auxiliary wells connected to the distribution system?

3.3 Well

- Is the well in a confined or unconfined aquifer?
- Is the well site subject to flooding?
- Is the well located near any immediate or potential sources of contamination (PSOCs)?
- Is there a Wellhead Protection Program (WHPP) in place?
- Is there a driller's log available?
- How deep is the well?
- How often is drawdown measured?
- What is the depth of the casing?
- What is the depth of the grout seal and does it meet primacy agency standards?
- Does the sanitary seal meet primacy agency standards?

- Does the casing extend above the floor or ground and meet primacy agency well construction standards?
- Does the well casing vent meet primacy agency well construction standards?
- If the well is in a pit, is it subject to flooding or runoff from impervious surfaces?
- Is the well pit checked and cleaned as part of regular maintenance?
- Do check valves, blow-off valves, and water meters function properly and does the PWS maintain them?
- Has the PWS properly protected the upper termination of the well?
- Does the PWS provide lightning protection?
- Is the pump intake located below maximum drawdown?
- Are check valves accessible for cleaning?

- Has there been any decline in water quality or quantity over time?
- Have the well casing and screens been inspected?

Figure 3-1: Sample minimum distances from well to pollution sources

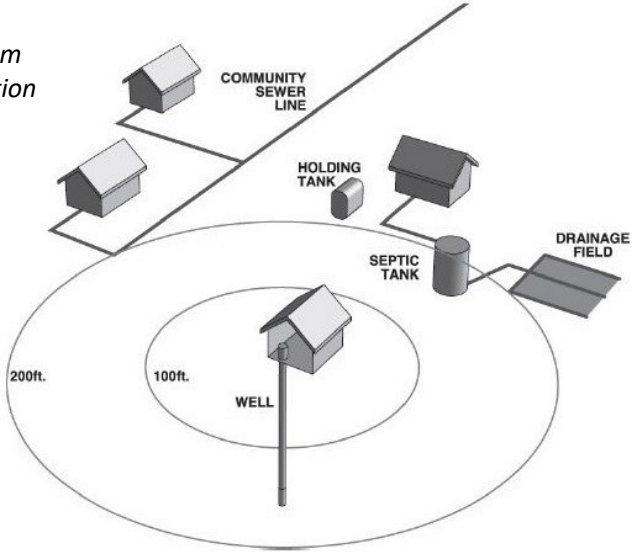


Table 3-1: Example minimum distances between wells & pollution sources

Source	Feet from well*
Watertight Sewers	50
Other Sewers	100
Septic Tanks	100
Sewage Field, Bed, or Pit	200
Animal Pens and Yards	200

* Consult the state regulatory agency for any setback requirements.

Figure 3-2: Components of a drinking water well with submersible pump

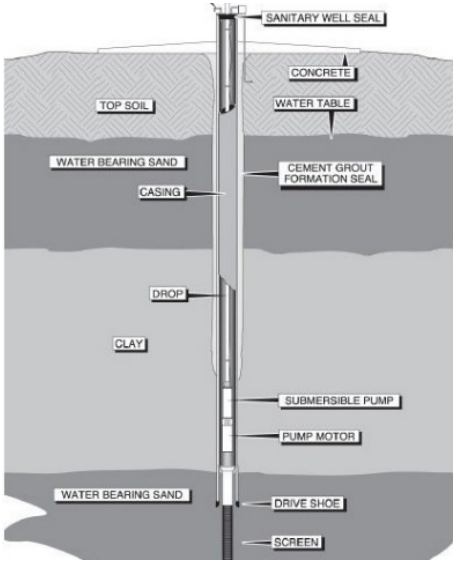


Figure 3-3: Lineshaft turbine upper well construction

Figure 3-4: Submersible turbine upper well construction

Figure 3-5: Lower well construction with submersible turbine pump

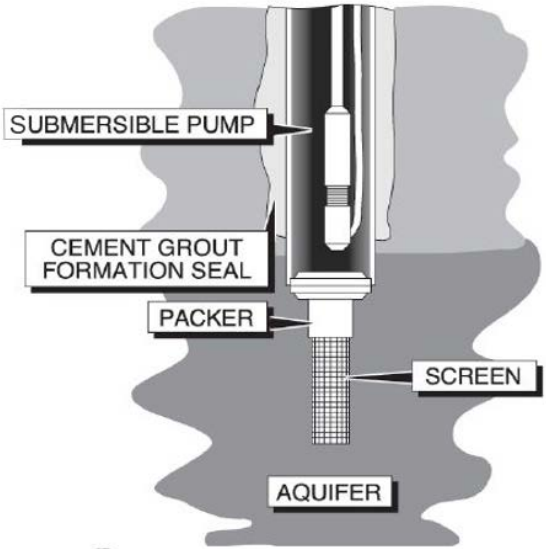


Figure 3-6: Pitless adapter detail

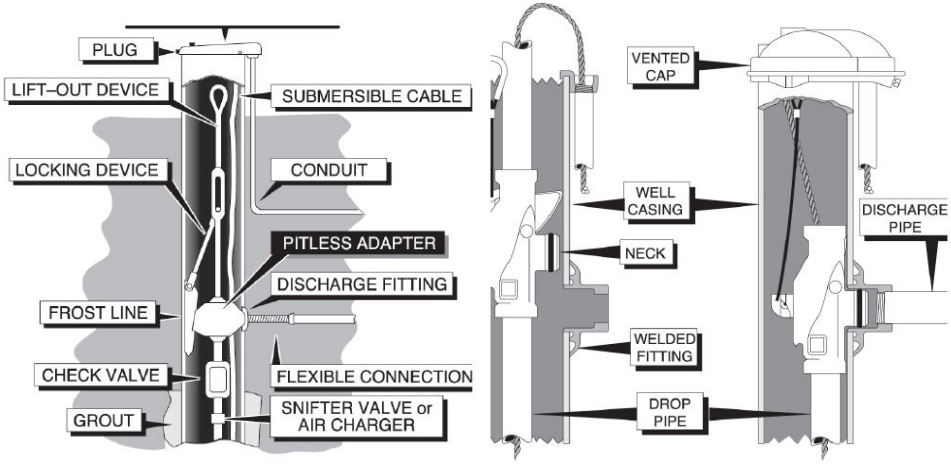


Figure 3-7: Split top well caps

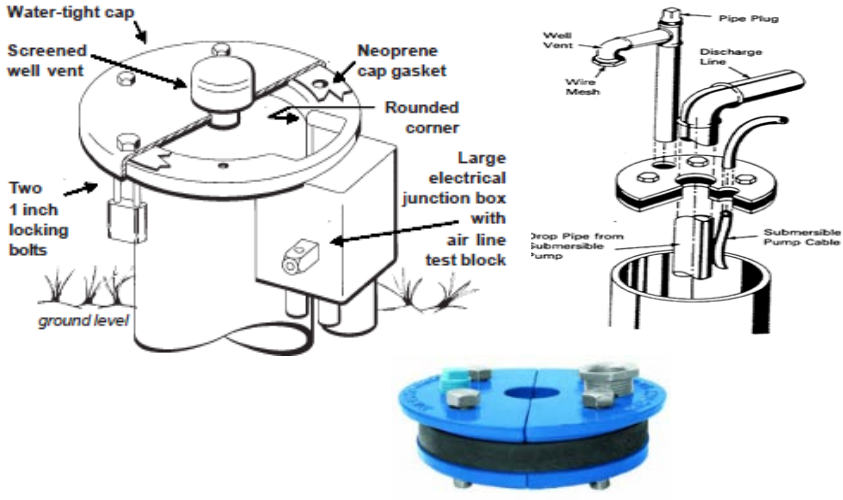
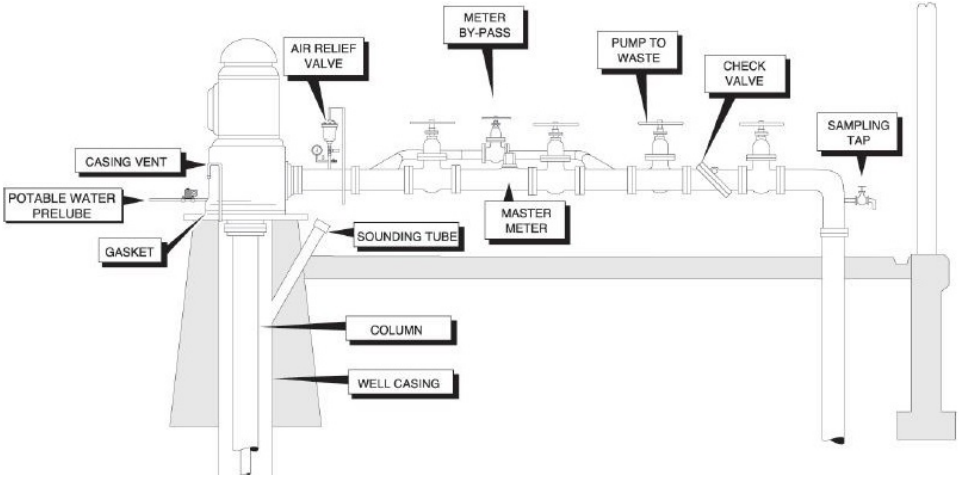


Figure 3-8: Well cap without sanitary seal (left) and well cap with sanitary seal (right)

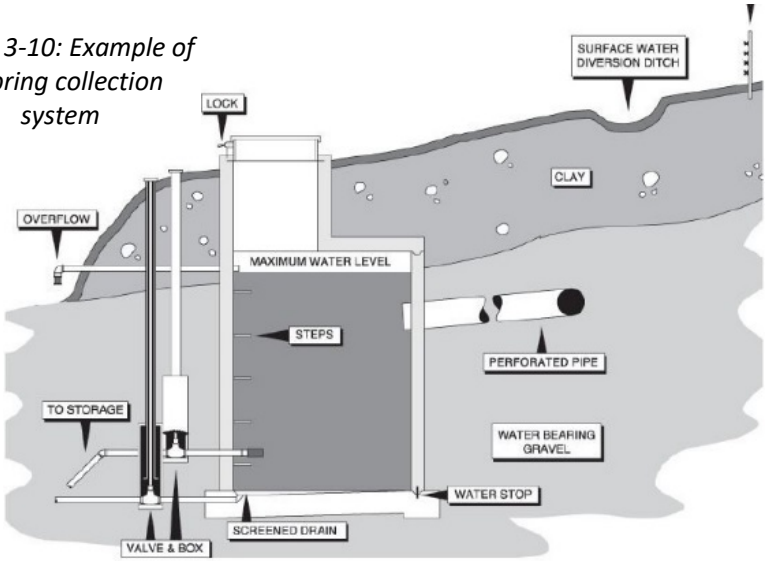
Figure 3-9: Turbine installation detail



3.4 Springs

- Has the PWS protected the recharge area?
- What activities and land uses take place in the recharge area?
- What conditions cause changes to the quality of the water?
- Has the spring source been sampled and evaluated for surface water influence?
- Is the site subject to flooding?
- Is the spring's intake adequately constructed and protected?
- Does the PWS provide adequate site protection?
- Is the spring box properly constructed?

Figure 3-10: Example of a spring collection system



3.5 Possible Significant Deficiencies for Ground Water Sources

- No or inadequate access buffer (restricted area) around well.
- No emergency or secondary well.
- Openings, holes, pitting, corrosion on well casing subjecting the well to surface water contamination.
- Inadequate sanitary seal.
- Bad seal around electrical conduit to submersible pump.
- No air venting of the well to prevent creating a vacuum within the well, which could draw in water of questionable quality from upper strata.
- No or cracked well pad, erosion under/around the pad, pad not sloped away from casing, or pad too small.
- Improperly constructed spring boxes, including cracks, holes, or lack of seal around electrical conduit; no means of locking access hatch.

- Spring supply is intermittent or inadequate to meet demand.
- Continuing decline in water quality or capacity.
- Spring supply is subject to surface water influence.

4 Surface Water Sources

4.1 Quantity

- What is the total design production capacity?
- What is the present average daily production?
- What is the maximum daily production?
- Is the safe yield sufficient to meet current and future demands?
- Is the quantity of the source adequate?
- If permits are required, is the facility operating within the limits? Are permits available?
- Does the PWS have an operational master meter?
- Does the PWS have interconnections with neighboring PWSs or a contingency plan for water outages?

4.2 Quality

- Does the PWS monitor raw water quality? Has raw water monitoring of the source(s) indicated the presence of *E. coli, Giardia lamblia,* or *Cryptosporidium*?
- Does the PWS track changes in raw water quality?
- What conditions cause fluctuations in water quality?
- Are there changes that could affect treatment?
- Are there any abandoned, unused, or auxiliary sources?
- Is there an emergency spill response plan?

4.3 Source Water Protection

- Has the PWS identified possible sources of fecal contamination and addressed them?
- Is the PWS implementing a plan to protect watershed or aquifer-recharge areas?
- What is the size of the protected area and who owns it?
- Are surveys of the watershed conducted regularly?
- What is the nature of the protection area?
- Is there an emergency spill response plan?

4.4 Reservoirs

- Is the area around the intake restricted?
- Are there any pollution sources near the intakes?
- Is the intake structure designed to draw water from different levels?
- Is the PWS drawing the highest quality water?
- How often are intakes inspected?
- Does the PWS add any chemicals to the reservoir?
- When did the PWS last have the dam inspected for safety (if applicable)?

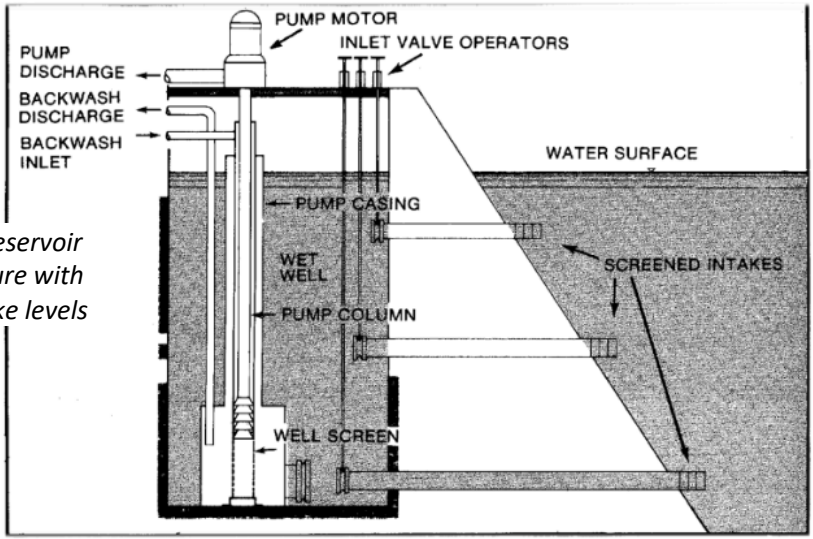


Figure 4-1: Reservoir intake structure with different intake levels

4.5 Streams and Rivers

- Is the area around the intake restricted and clearly marked?
- Are there any pollution sources near the intakes?
- How often are the intakes inspected?
- What conditions cause fluctuations in water quality?
- Are any chemicals being added at the intake structure?

4.6 Infiltration Galleries

- Does the PWS provide adequate security for the pump house and the area around the collection area?
- What triggers a more thorough survey of the collection systems?
- If the supply is impounded behind a dam, when was the dam last inspected by the state or a consulting engineer?

Figure 4-2: Example of an infiltration gallery

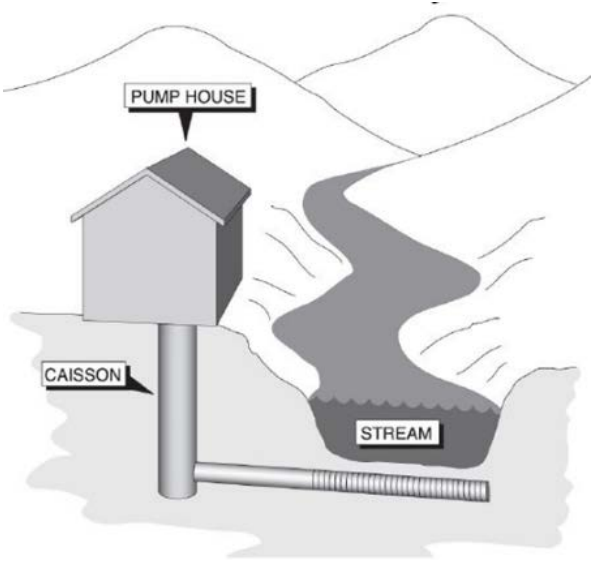
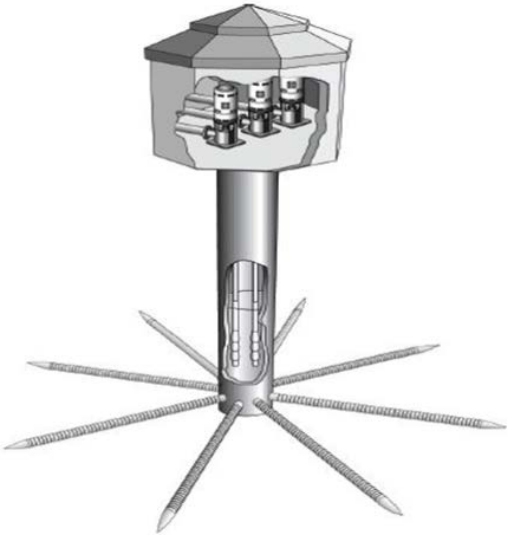


Figure 4-3: Ranney well



4.7 Possible Significant Deficiencies for Surface Water Sources

- No or inadequate access buffer (restricted area) around surface water intake structure.
- Inability to draw water from different depths at surface intakes.
- No emergency or secondary source.
- Cross-connections between treated and untreated water.

5 Water Supply Pumps, Pumping Facilities and Controls

5.1 Pumping Equipment and Appurtenances

- What are the number (including reserves), location, and type of pumps?
- Is the actual capacity of the pumping facility adequate to meet the demand?
- When and how are pump capacities determined?
- What is the condition of the equipment?
  - Are all units operable?
  - Excessive noise, vibration, heat or odors?
  - Leaking water?
  - Dirt and grime?
  - Leaking lubricant?
- Are the pumping systems equipped with:
  - Check or isolation valves?
  - Pressure gauges?
  - Flow meter?
  - Blow-off line?
  - Air release valve?

- How often are all pump stations visited?
- Are there any cross-connections present?
- Are the correct types of lubricant used?
- Is the frequency of addition and amount of lubrication adequate?

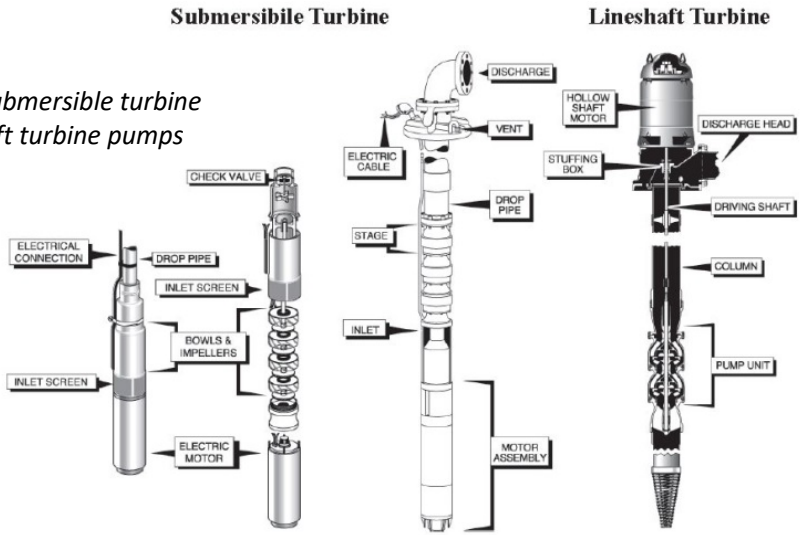


Figure 5-1: Submersible turbine and lineshaft turbine pumps

Figure 5-2: Lineshaft turbine pump station

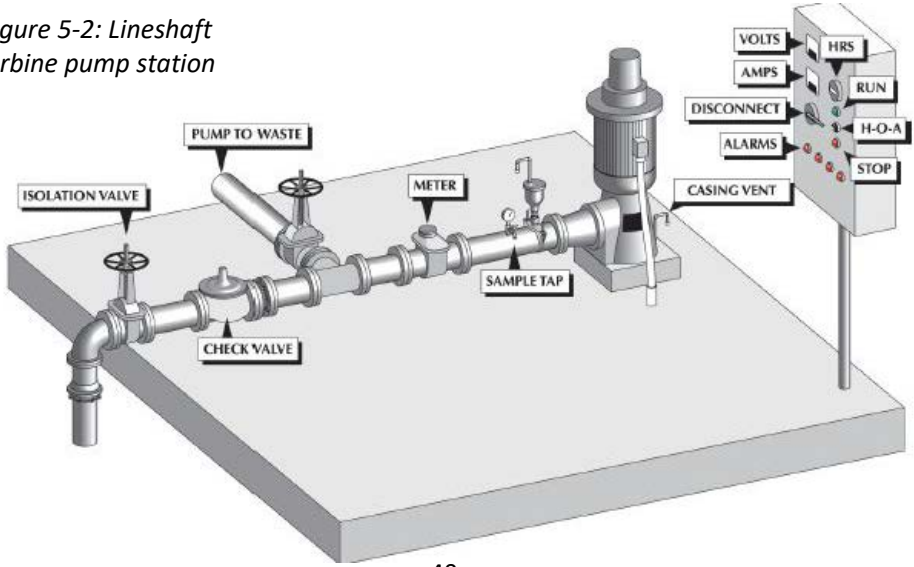
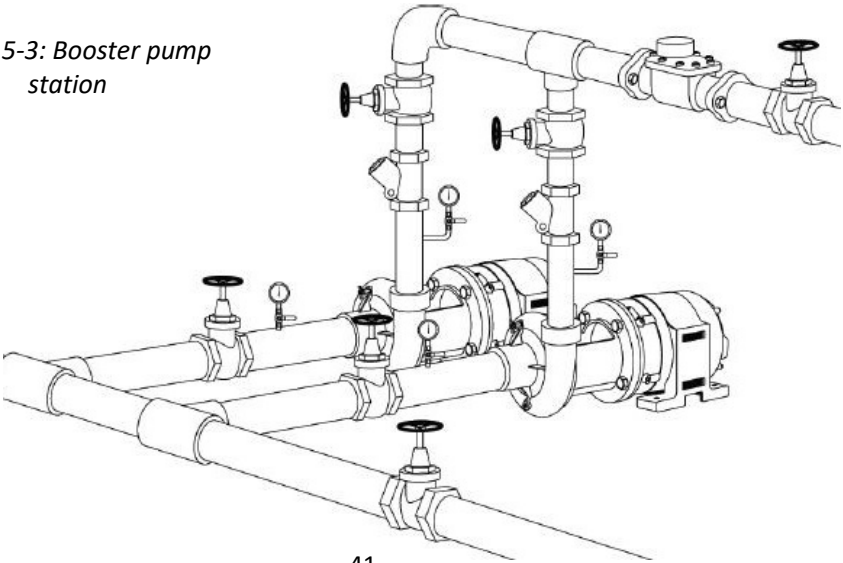


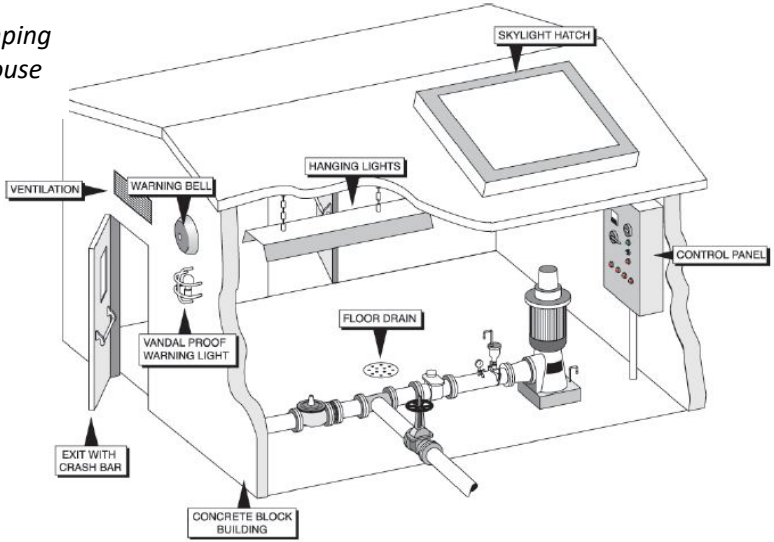
Figure 5-3: Booster pump station



5.2 Pumping Facilities

- Is security adequate?
- Is the building and equipment protected from flooding?
- What is the structural condition of the building?
- Can the operator access and remove equipment from the building for maintenance?
- Is the building orderly and clean?
- Does the PWS use the pumping station for storage?
- Is safety equipment adequate?

Figure 5-4: Pumping station/well house



5.3 Controls

- Is the motor control system adequately designed and reliable?
- Is the pump system equipped with an adequate failure alarm system?
- Does the auxiliary equipment have fail-safe devices?
- Are controls equipped with elapsed time meters?
- Does the PWS adequately protect controls?
- Does the PWS adequately maintain control systems?

Figure 5-5: Low-flow switch

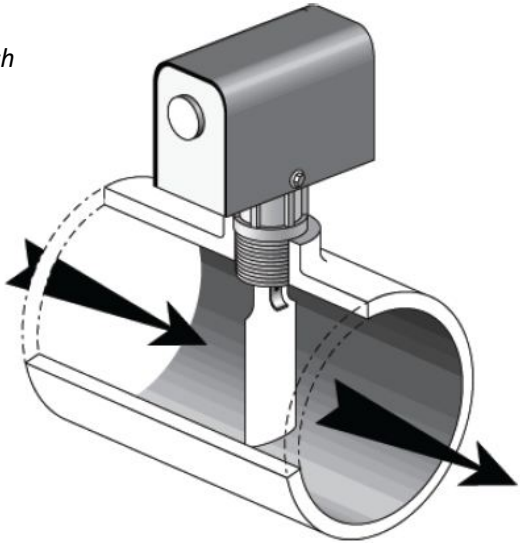
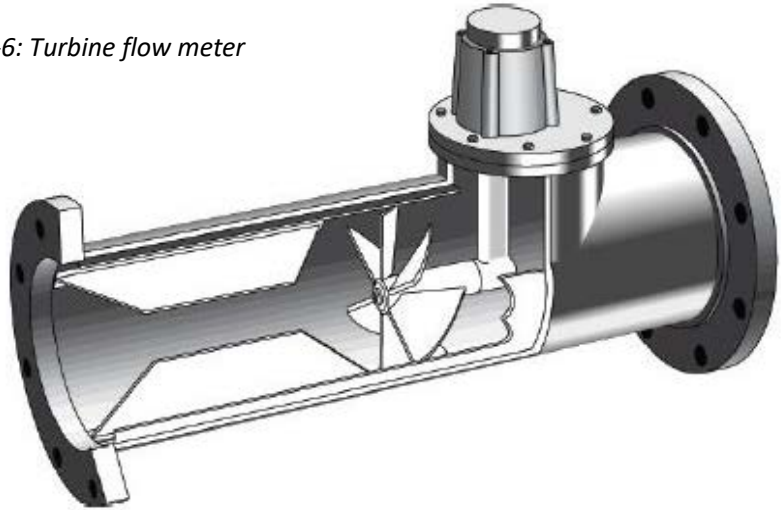


Figure 5-6: Turbine flow meter



5.4 Auxiliary Power

- Is auxiliary power needed and, if so, is it provided?
- What type of auxiliary power does the PWS provide? What conditions activate auxiliary power?
- Does the auxiliary power unit (APU) supply ALL electrical systems at the pumping station?
- If the emergency generator is located inside the building, is a carbon monoxide detector installed?
- Where is the fuel tank located?
- Does the PWS regularly exercise and properly test the APU?
- Is the APU secure and maintained in good condition?
- Are there any cross-connections between the auxiliary power system and potable water?

5.5 Operation and Maintenance

- Are the number and skill level of the staff adequate for operating and maintaining the pumping facilities?
- Does the operator maintain adequate operational records for pumping facilities?
- How often are the pump stations visited?
- Are the pump stations protected against vandalism and intrusion?
- Does the water system have written standard operating procedures (SOPs) available, and do all operators follow them?
- Is there an established and documented preventive maintenance (PM) program?

5.6 Possible Significant Deficiencies for Pumps and Pumping Facilities

- Cross-connections.
- Inadequate/inoperable or unsecure control system.
- Inadequate alarm system for failure of booster pumps.
- No pressure gauge on pump discharge line or on pump suction side.
- No cut off for low pressure on pump suction side.
- No emergency power as required by the state.

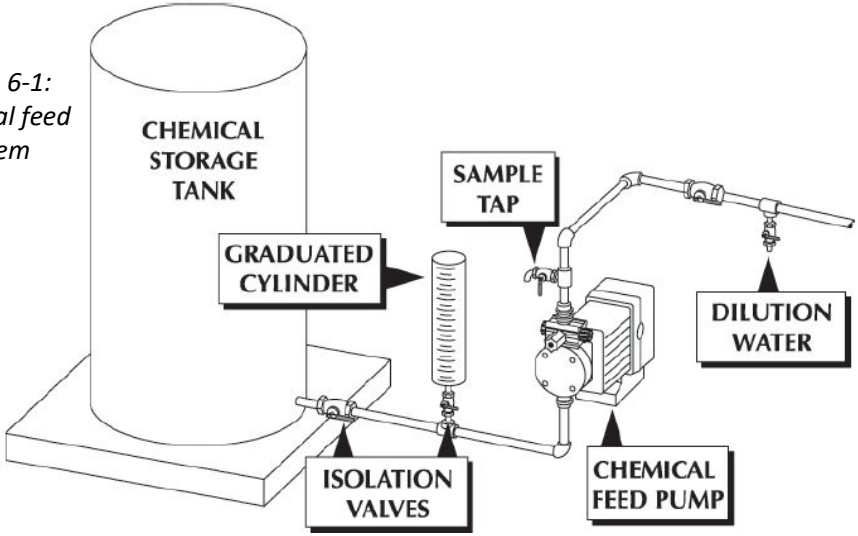
6 Chemical Feed and Storage Systems

6.1 Chemical Feed Systems

- What chemicals are used?
- What are the amounts of chemicals used?
- Where is the application point of each chemical?
- Does the PWS have adequate process control monitoring and testing procedures?
- What is the condition of the chemical feed equipment?
- Does the operator routinely calibrate the chemical feed equipment?
- Are instrumentation and controls for the process adequate, operational, and used?
- Is chemical storage adequate and safe?
- Do daily operating records reflect chemical dosages and total quantities used?

- Is the chemical feed system tied to flow (i.e., flow paced)?
- Is there an operating 4-in-1 valve or equivalent on each feed pump?
- Is there a hazardous chemicals protection and communication program in place?
- Is there appropriate safety equipment (e.g., cartridge respirator for calcium hypochlorite) and personal protective equipment (PPE) (e.g., goggles and gloves) available and in use? Does the operator have the training needed to use the safety equipment?
- Is the building as clean and dry as possible?
- Is any outside chemical storage protected?
- Are all chemicals labeled and listed as NSF or UL approved for drinking water?
- How many days of chemical use are stored?

Figure 6-1: Chemical feed system



6.2 Fluoridation

- Can the operator answer basic questions about the fluoridation process, including what they need to do, when, and why?
- Is there a proper concentration of fluoride in the distribution system at all times?
- Does the operator test fluoride concentrations in the PWS daily?
- Does the fluoride concentration vary from day to day?
- Does the operator perform testing correctly?
- How often does the operator calibrate the testing instrument? When was the last calibration?
- Is there a water meter on the inlet line when using a fluoride saturator?
- How often does the operator clean the fluoride saturator tank?
- Is there a scale for weighing the solution tank for a liquid acid system?

- How often are the scales calibrated?
- Does a fail-safe switch control the fluoride feed system?

Figure 6-2: Fluoride acid feed system

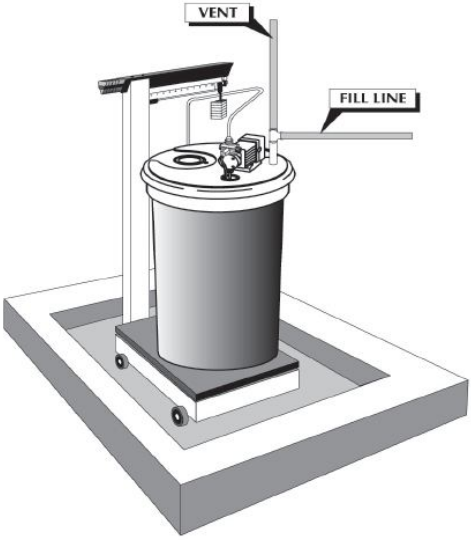
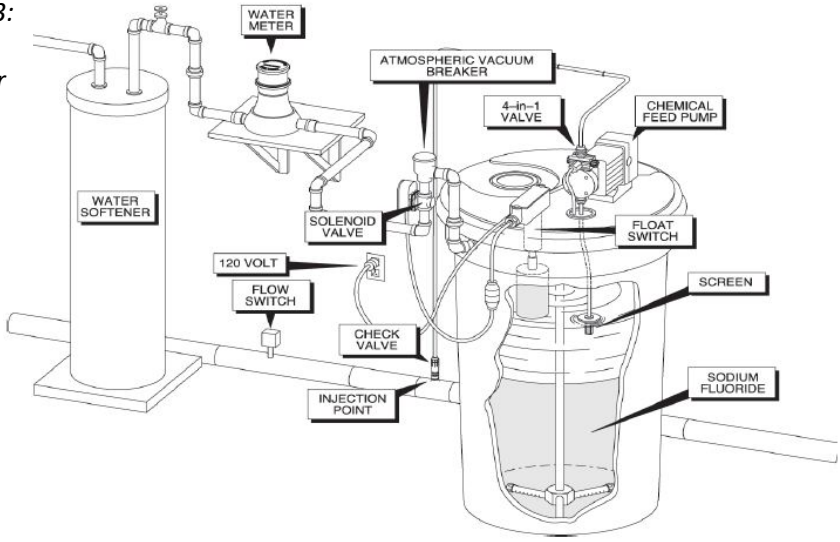


Figure 6-3: Fluoride saturator



6.3 Possible Significant Deficiencies for Chemical Feed Systems

- The chemical feed pump is the wrong size, not working, or needs repair.
- No 4-in-1 valve if the pump supports a critical chemical feed process (i.e., fluoride, coagulant feed, or chlorine).
- The chemical feed control system is inoperable.
- There are cross-connections present.
- There is no means to determine fluoride residual (e.g., a flow meter and associated saturator to calculate the feed rate or a fluoride test kit).
- Failure to use NSF or ANSI-approved chemicals.
- Improperly labeled chemicals or missing labels.
- Operator is not performing tests daily for treatment chemicals added.
- There is no check valve between metering pump and inlet pipe to prevent siphoning of chemical to drinking water.

7 Chemical Contaminant Removal

7.1 General Considerations

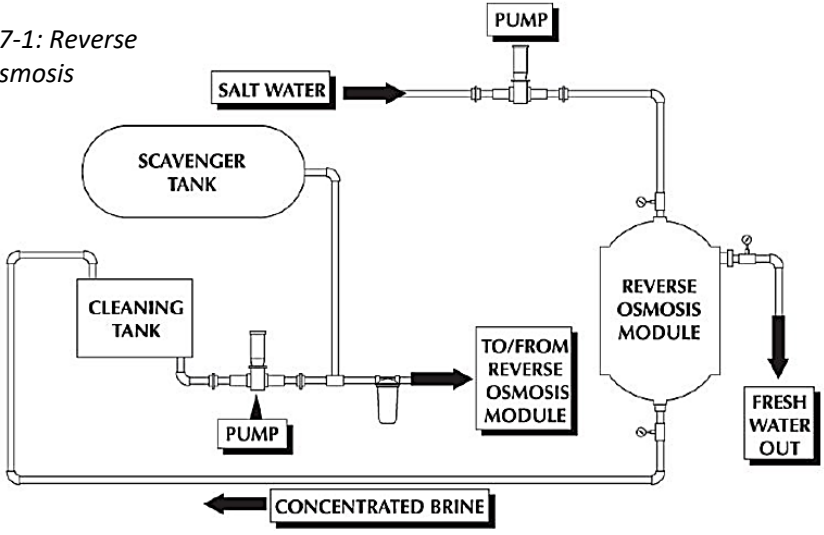
- What treatment process is used?
- What contaminant is the treatment used for?
- What are the treatment goals?
- Is the test equipment to monitor the data appropriate and in good working order?
- What operational data is the PWS collecting?
- Are all automatic controls in operation?
- Are analyses conducted to assess removal?
- Is the facility performing adequate process control testing?

7.2 Reverse Osmosis (RO)

- What performance testing is the PWS conducting?
- What chemicals are being fed and at what dosages?
- Is there a pretreatment filtration step?
- Are automatic controls in operation?
- If the PWS blends RO-treated water with water that bypasses RO treatment, how is the blending ratio determined and is the final water satisfactory?

Note: The sanitary deficiencies related to chemical feed systems in 6.1, page 51, also apply to this section.

Figure 7-1: Reverse osmosis



7.3 Corrosion Control

- What are the results of lead and copper sampling during the current monitoring period?
- What corrosion control is being used?
- Is the PWS required to provide Optimal Corrosion Control Treatment?
- If applicable, is the PWS meeting the state-designated water quality parameters at both the customers' taps and the distribution system entry point(s)?
- What process-control sampling does the operator conduct at the plant and throughout the distribution system as part of the corrosion control program?

7.4 Iron and Manganese Removal

- Do visual observations confirm the removal process is performing adequately?
- What chemicals are used and in what amounts?
- Where does the operator apply chemicals and how are they monitored?

Figure 7-2: Manganese green sand filtration intermittent regeneration (IR)

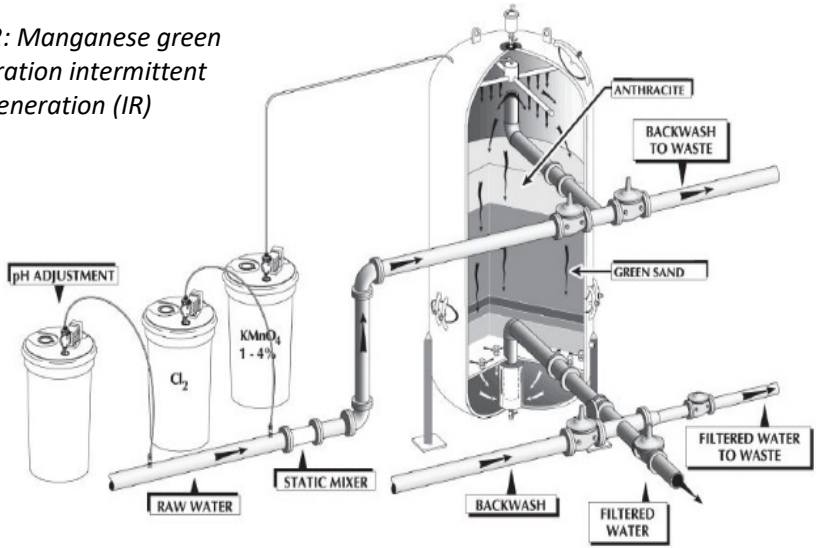
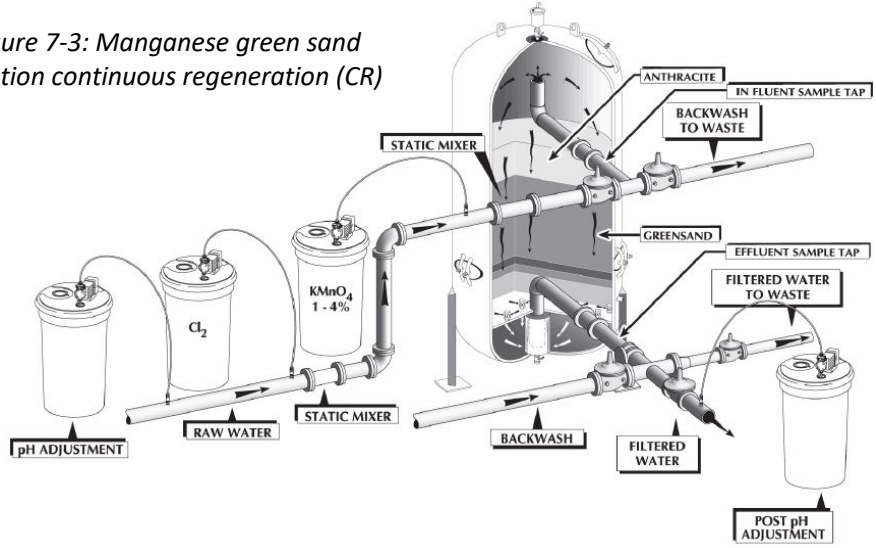


Figure 7-3: Manganese green sand filtration continuous regeneration (CR)



7.5 Organics Removal

- What contaminant is the treatment used for?
- Which removal process does the water system use?
- What testing does the operator conduct to determine the effectiveness of the removal process?
- How are the treatment processes monitored and maintained?
- How often is GAC or ion exchange resin replaced?

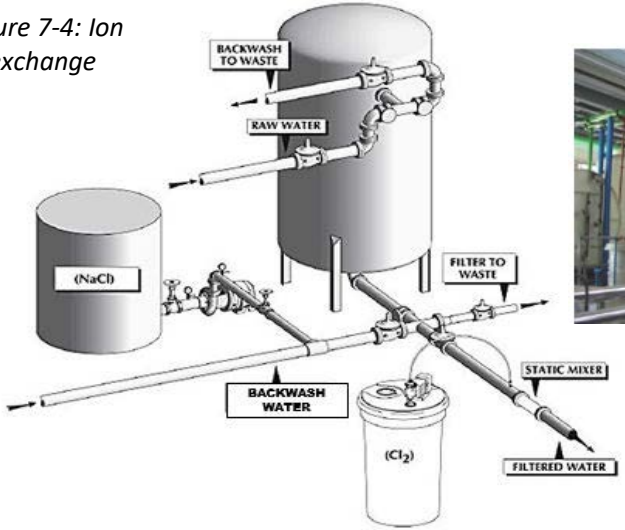
7.6 Aeration

- What type of aeration system is used?
- What process-control parameters does the operator monitor to evaluate performance?
- Are there contaminants nearby that the blower could draw into the air supply?
- What types of operational problems has the facility experienced that could contribute to poor performance of the aeration device?
- After aeration, does the PWS adequately disinfect the effluent before it enters the water distribution system?
- What is the condition, both inside and outside, of the aerator?

7.7 Water Softening

- What are the treatment goals?
- Is the facility tracking the chemicals used?
- Is the facility meeting the Total Organic Carbon (TOC) removal requirements (if applicable) of the Stage 1 DBPR?
- What is the operator's knowledge of the softening process?

Figure 7-4: Ion exchange



7.8 Possible Significant Deficiencies for Chemical Contaminant Removal

- Improper storage and handling of powdered activated carbon (combustion/explosion hazard).
- Proximity of compressors to PSOCs for aeration processes.
- No or inoperable low flow/low pressure switches on acid, chemical, corrosion control or scale inhibitor feed lines.
- Missing or improper backflow prevention for chemical feed lines.
- No process control monitoring.
- No regular testing to determine removal performance.

8 Disinfection

8.1 Disinfection Methods

- Can the operator answer basic questions about the specifics of their disinfection process? Do they know when and where disinfection occurs and why they are dosing at particular sites?
- Have there been any interruptions in disinfection? If so, why?
- Does the operator measure and record the temperature and pH of the water at the point of chlorine application?
- Are spare chemical feed pumps and repair kits available?
- Is the contact time between the point of disinfection and the first customer adequate to meet the required inactivation?
- Was the PWS required to prepare a disinfection profile? Is the profile available for review?
- How is disinfectant residual measured and recorded?
- Is test equipment maintained and are reagents replaced?

- Is a proper residual entering the distribution system at all times?
- What disinfectant residual does the PWS maintain?

8.2 Hypochlorination Systems

- What kind of hypochlorite is used (e.g., calcium, sodium, or others)?
- Is there a cover on the solution tank to minimize corrosive vapors?
- Is there adequate spill containment?
- What safety procedures does the operator follow during chemical handling and mixing?

8.3 Gas Chlorination Systems

- How does the operator detect leaks? Are automatic detectors or some manual form of detection used?
- Is the sensor tube for the automatic detector near the floor level? Is there a screen on the end of tube?
- Is the chlorination equipment properly contained?
- Are there any cross-connections in the chlorine feed make-up water or injection points?
- Is there an alarm tied to interruptions in the chlorine feed?
- Does the PWS use automation, flow pacing, chlorine residual analyzer, or another system to adjust feed rates? Does it work?
- Is there more than one cylinder, and are they equipped with a manifold and an automatic switch-over to avoid running out of chlorine?
- Are the cylinders on a working scale?

- Are the valves on the tanks only open a quarter turn and have a wrench in place for quick turnoff?
- Does the operator properly mark all cylinders and restrain them to prevent falling?
- Does the operator follow safe practices during cylinder changes and maintenance?
- How many individuals are present when the chlorine cylinders are changed?
- What type of respiratory protection is used?
- Is there an emergency plan, and when was it last practiced?
- What is the operating condition of the chlorinator?
- Is redundant equipment available, and are there adequate spare parts?
- Are the appropriate lighting, guards, and railings in place? Are there other safety concerns, such as electrical hazards?

Figure 8-1: Chlorine gas treatment room

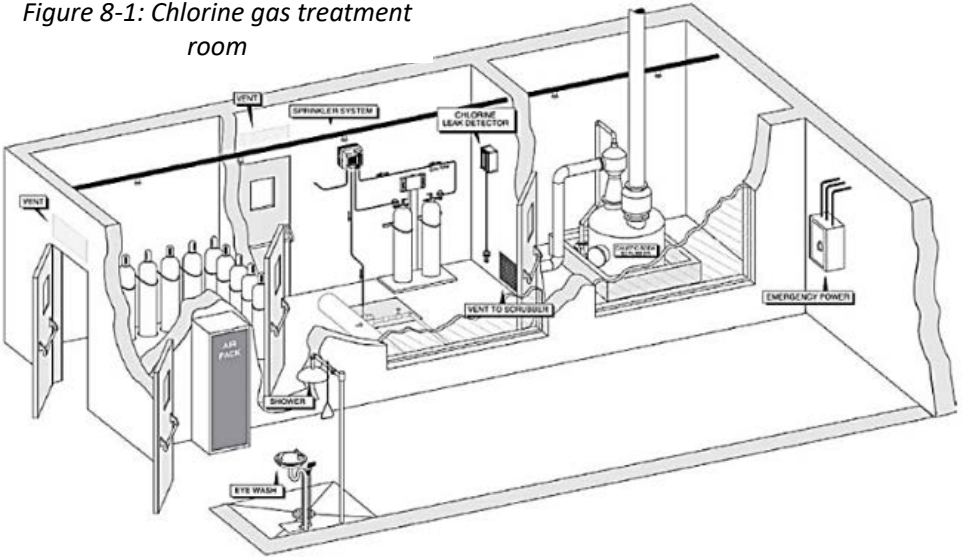
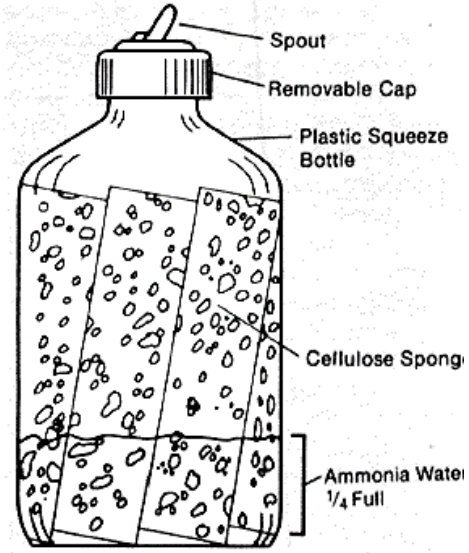


Figure 8-2: Ammonia squeeze bottle used to detect chlorine gas leaks



8.4 Chloramines

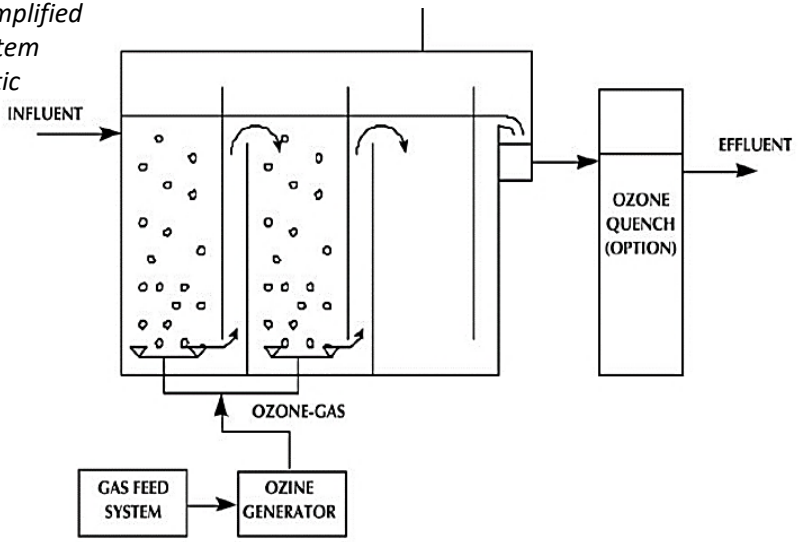
- What are the treatment objectives for chloramination?
- What type of process control monitoring does the operator conduct?
- What are the points of application for the chlorine and ammonia?
- Where is chloramine residual being monitored?
- Does the PWS sell water to communities that use chlorine instead of chloramines?
- Has management provided for the safety of the operator responsible for the O&M of the chloramination processes?
- Has the water system notified critical populations of the use of chloramines?

8.5 Ozone

- Why is the PWS using ozone?
- What secondary disinfectant does the water system use?
- What type of process control monitoring does the PWS conduct?
- How and where does the PWS generate ozone?
- Is there an ozone monitoring plan to address the entire ozonation process?
- What are the application points for the ozone?
- How is ozone inactivation (CT) determined?
- Does the PWS have an operation and maintenance (O&M) plan for the ozone system?
- Is the PWS complying with the MCL for bromate and the monitoring requirements under the DBPRs?

- Has management provided for the safety of the operators responsible for the O&M of all ozonation processes?

Figure 8-3: Simplified ozone system schematic



8.6 Ultraviolet Disinfection Systems

- Is the PWS meeting its UV dose and inactivation requirements?
- If required, has the PWS met the requirement to treat at least 95% of the water delivered to the public within validated conditions for each month?
- Does the operator monitor the UV reactor for validated conditions?
- Are UV reactor maintenance procedures in place and followed?
- Is upstream treatment performance meeting the requirements?
- Have there been changes to the treatment train?
  - Inlet and outlet piping or channel conditions.
  - Plant hydraulics or in plant flows.
  - Any upstream treatment.
  - UV lamps or sensors-make/models should match those approved by the state

8.7 Chlorine Dioxide

- Why is the water system using chlorine dioxide and what are the treatment objectives?
- Is the water system using sodium chlorite and, if so, at what percentage?
- How and where is the sodium chlorite stored?
- What is the secondary disinfectant being used?
- What is the purity of the chlorine dioxide produced?
- Does the operator adjust the chlorine gas feed rate as required and recalibrate the equipment according to manufacturer specifications?
- Are sample petcocks available to perform the required sampling?
- What are the application points for the chlorine dioxide? Is the CT value properly calculated?

- Is the PWS complying with the MRDL for chlorine dioxide and MCL for chlorite as well as the monitoring requirements under the DBPRs?
- Has management provided for the safety of the operators responsible for the O&M of the chlorine dioxide generation processes?

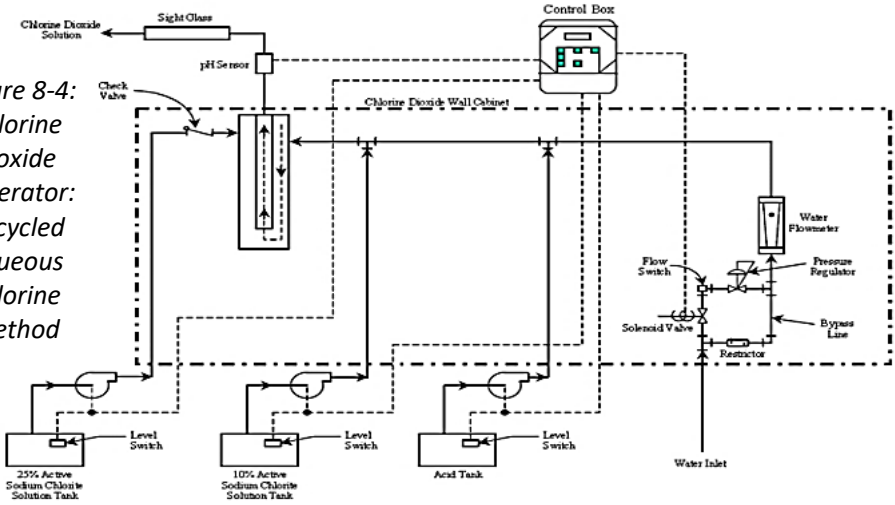


Figure 8-4: Chlorine dioxide generator: Recycled aqueous chlorine method

8.8 Possible Significant Deficiencies for Disinfection

- Missing no-flow/fail-safe device for the chlorination system.
- Incompatible storage of chemicals with chlorine.
- No redundant chemical feed pumps for disinfection system.
- Inoperable chemical feed pump causes interruption in disinfection process.
- Cross-connection in disinfection process.
- No backflow/back siphonage prevention devices for make-up water.
- UV lamps are not cleaned routinely or problems meeting inactivation requirements.
- No process control monitoring.
- Gas chlorine cylinders are not properly restrained.
- No determination of inactivation.
- There are interruptions in the requisite disinfection process.

9 Turbidity Removal

9.1 Conventional Treatment

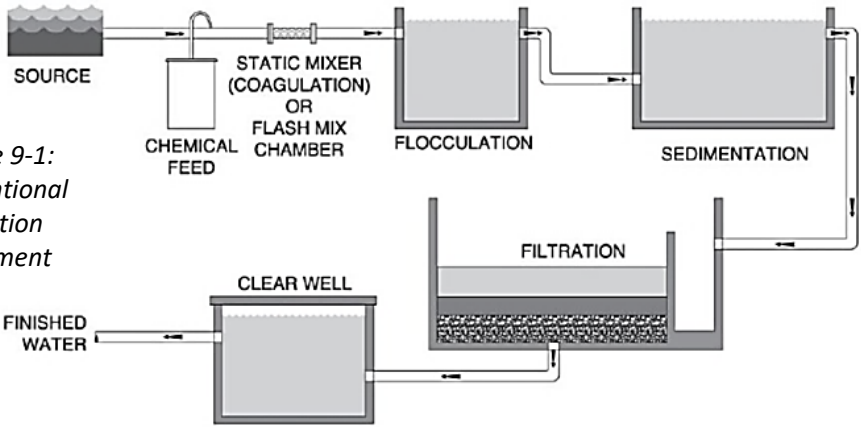


Figure 9-1: Conventional filtration treatment

9.1.1 Coagulation – Rapid Mix

- Does treatment include continuous coagulant feed when the plant is in operation?
- What type and combination of coagulants are used?
- Does the operator understand the purpose of each coagulant chemical used?
- How does the operator determine the dosage of each coagulant chemical?
- Is there a process control plan for coagulation addition?
- Is the rapid mix process adequate?
- Is the flocculation process adequate?

9.1.2 Sedimentation

- Is the sedimentation process performing adequately?
- Is the clarifier performing adequately?
- How does the PWS start and stop operations?
- Is there visible floc carryover onto the filters?
- Does the operator monitor settled water turbidity?

9.1.3 Filtration

- Is the filtration process performing adequately?
- Is there adequate pretreatment?
- Are there rapid fluctuations in the flow through the filter?
- What controls and assessments does the operator use to evaluate filter performance?

- Are instrumentation and controls for the process adequate, operational, and in service?
- What initiates a backwash, and is there a SOP in place?
- What is the return to service process for filters?
- How is the backwash water treated and returned?
- What is the rate of backwash water return flow?
- If the plant is a conventional plant, is it meeting the DBP precursor removal requirements of the Stage 1 DBPR?
- Is there a plan for media replacement and filter inspection?

9.2 Direct Filtration

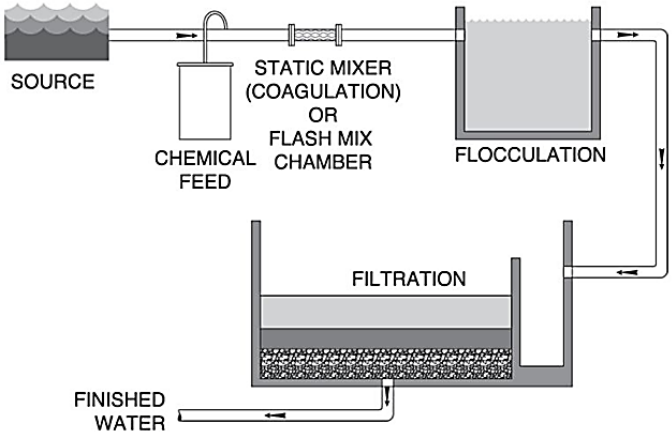
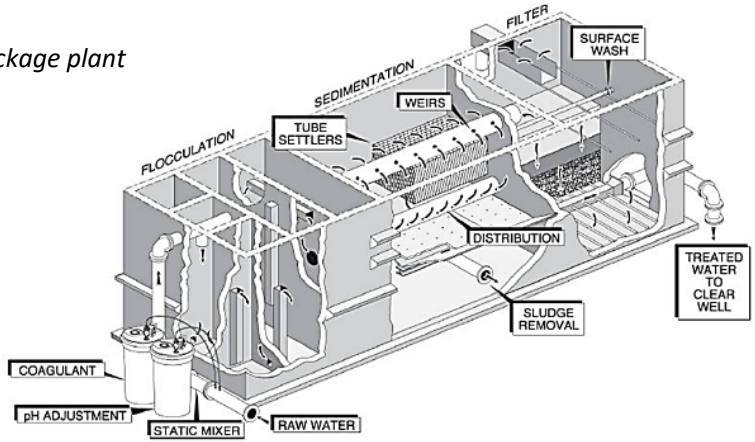


Figure 9-2: Direct filtration treatment

- See the questions, in 9.1.1, page 91, on considerations for coagulation-rapid mix.
- See the questions, in 9.1.3, page 92, on considerations for filtration.
- Does the source water or treated water quality still justify direct filtration?

9.3 Package Filtration

Figure 9-3: Package plant



- See the questions, in 9.1.1, page 91, for considerations for coagulation-rapid mix.
- See the questions, in 9.1.2, page 92, for considerations for sedimentation.
- See the questions, in 9.1.3, page 92, for considerations for filtration.
- Is there any cross-contamination at common walls between water at different stages of treatment?
- Is the package plant operated within design criteria or state requirements or limits?
- Is the operator maintaining the plant according to manufacturer recommendations?
- Are repair and replacement parts still available from the manufacturer?

9.4 Slow Sand Filtration

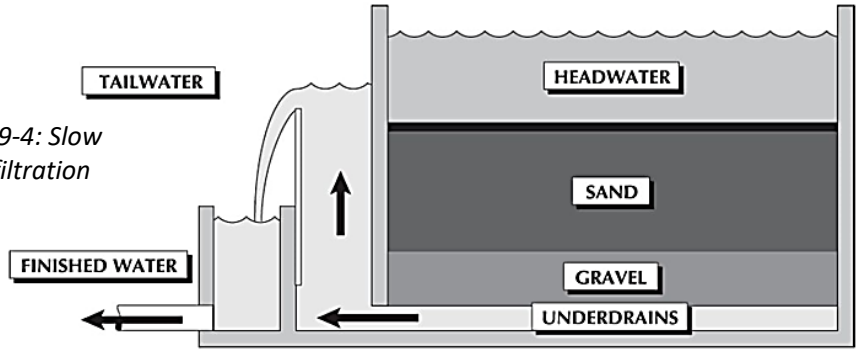
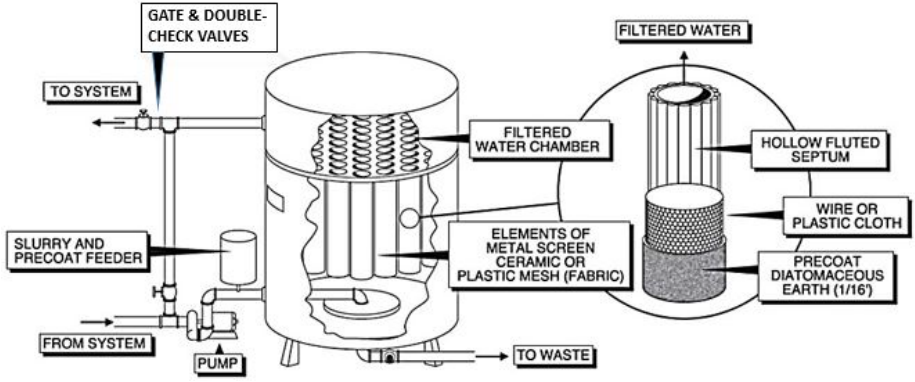


Figure 9-4: Slow sand filtration

- What pretreatment does the water system use, if any?
- What method does the operator use to clean the slow sand filters?
- Are there redundant slow sand filters?
- Is the slow sand filter covered and light-free?
- Are some filters taken out of service seasonally?
- What is the filter maintenance schedule and return- to-service process?

9.5 Diatomaceous Earth Filtration

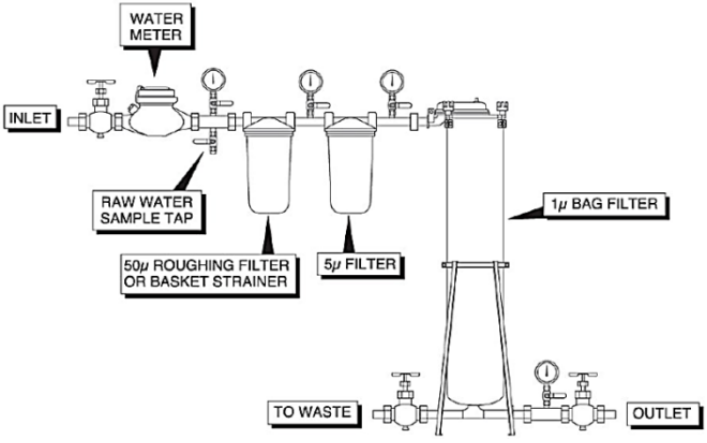
Figure 9-5: Diatomaceous earth filtration



- What levels of pre-coat and continuous body feed does the operator maintain?
- How does the operator handle flow interruptions?
- When does the operator initiate backwashing?

9.6 Bag and Cartridge Filtration

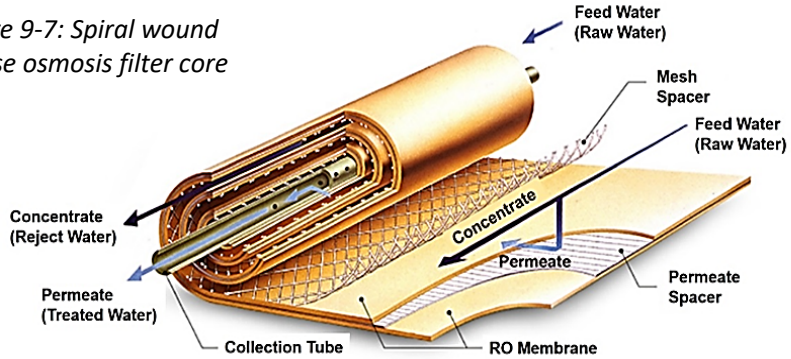
Figure 9-6: Bag and cartridge filtration



- What type of pretreatment is used?
- Have the bags or cartridges undergone a demonstration study to show removal achieved?
- Does the final unit provide the required level of removal?
- What are the average and the shortest times between filter replacements?
- How is filter integrity and the need for filter replacement monitored?
- Is the filter being used the same model as was approved by the state?
- Is there an inventory of replacement filters and are replacement filters readily available from the manufacturer?

9.7 Membrane Filtration

Figure 9-7: Spiral wound reverse osmosis filter core



- What type of membrane is used, and what is its intended purpose?
- What type of pretreatment is used?
- How is membrane integrity being determined?
- What measures does the operator use to control membrane fouling?
- What is the percentage recovery and what technique does the operator employ for backwash?
- If backwash is recycled, how is it treated and what is the percentage added to the raw water supply?
- What is the frequency of cleaning and disposal of cleaning fluids and brines?
- What is the condition of the plant, gauges, and appurtenances?
- Is the membrane filtration plant's operation consistent with primacy agency conditions or limits?
- What is the replacement schedule for the membranes?

9.8 Possible Significant Deficiencies for Turbidity Removal

- Failure to calibrate turbidity monitoring equipment or to record above the regulatory threshold (i.e., “capped”).
- Inadequate process control testing or record keeping.
- Key chemical feeds are not flow-paced.
- No overfeed protection of a chemical feed (lack of flow-control switch).
- Inadequate process control sample locations (e.g., no way to measure dosages).
- Insufficient or missing backflow prevention for surface wash or air scour filters.
- Intermittent coagulant feed.
- Insufficient mixing or too vigorous mixing at chemical feed points.

- Exceeding any of the NPDWRs turbidity performance requirements resulting in treatment technique violations.
- No integrity testing of membranes.
- Membrane, bag, or cartridge filters replaced with unapproved models.
- Alternative filtration technologies not approved by the state or not operated according to state-approved conditions.

10 Finished Water Storage Facilities

10.1 Gravity Storage

- Is the storage system designed for direct pumping or floating on the distribution system?
- Is the storage capacity adequate?
- Is the storage over-sized?
- Do storage tanks turn over regularly?
- Is the elevation of the tank sufficient to maintain pressure throughout the distribution system?
- Is there a need for separate pressure zones?
- Does the operator understand the controls that regulate tank water levels?
- Are control systems reliable and properly protected?
- Is the water level indicator operational?

- Is there a cleaning, inspection, and maintenance program?
- Is all finished water storage covered?
  - Air Vents:
    - Is the vent equipped with a non-corrodible screen that meets state or other standards?
    - Does the vent terminate above the roof and meet state or other standards?
  - Overflows:
    - Does the overflow outlet terminate above the ground and is it protected against flooding and animal intrusion?
    - Is the overflow outlet protected with a non-corrodible screen or flapper valve?
    - Are the tank drain and overflow pipe directly connected to a storm drain or sanitary sewer?

- What is the design and condition of the rooftop access hatches?
- Is the seal on the rooftop access hatch in place and in good condition?
- Does the operator keep the access hatch locked, and do authorized personnel have access to the keys or combinations?
- Condition of tank drain pipe?
- Are there any other openings in the tank walls, wall-to-roof connections, or the roof?
- Are the cathodic protection access plates watertight?
- If there is roof penetration for a water level indicator cable, is it sealed to prevent contamination?
- Are there other unsealed roof penetrations?
- Are there sewer lines in the vicinity of an in-ground storage tank and does the separation distance meet state requirements?

- Are there cracks in the walls or covers of the in-ground concrete storage tanks?
- Is there evidence of foundation pad damage or foundation to tank connection damage?
- Is there protection from flooding?
- Can the tank be isolated from the PWS? Are there procedures to sustain the water supply when the storage tank is out of service for maintenance?
- Has the PWS protected the site against vandalism?
- Does the PWS use approved interior surface coatings?
- Does the PWS monitor for coliform and volatile organic contaminants (VOCs) before returning the tank to service?
- Has the PWS protected the tank against icing?
- Are there indications that the tank may not be structurally sound?

- Has the PWS protected the tank against corrosion?
- Has the tank been protected for seismic events?
- Does the operator or contractors properly disinfect storage tanks following interior maintenance?
- Are emergency procedures established?
- Does the operator follow safety precautions?
- If the tank is wooden, does the operator manage it in a manner to minimize an increase in bacterial count?

Figure 10-1: In-ground storage

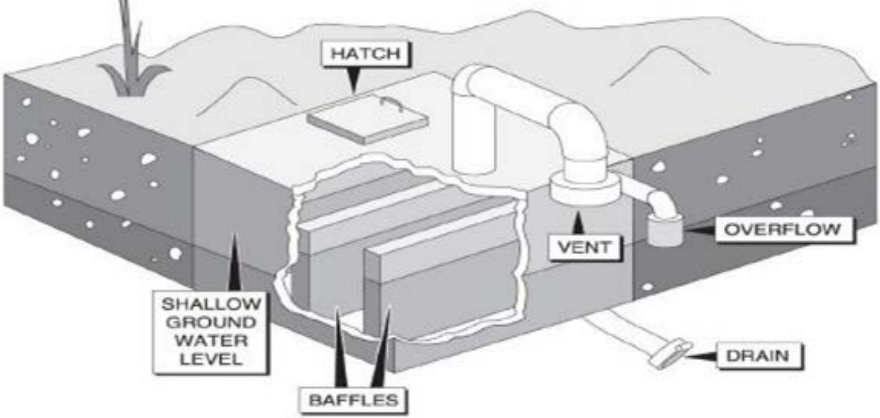


Figure 10-2: Elevated storage and ground level storage

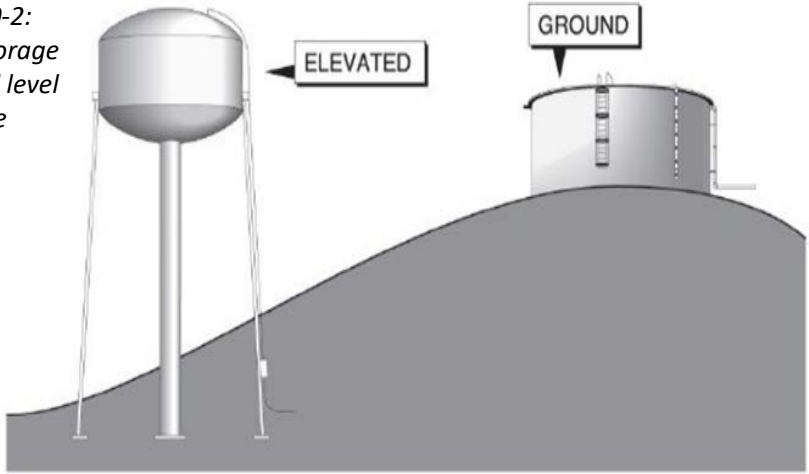


Figure 10-3: Large vs. narrow diameter tanks

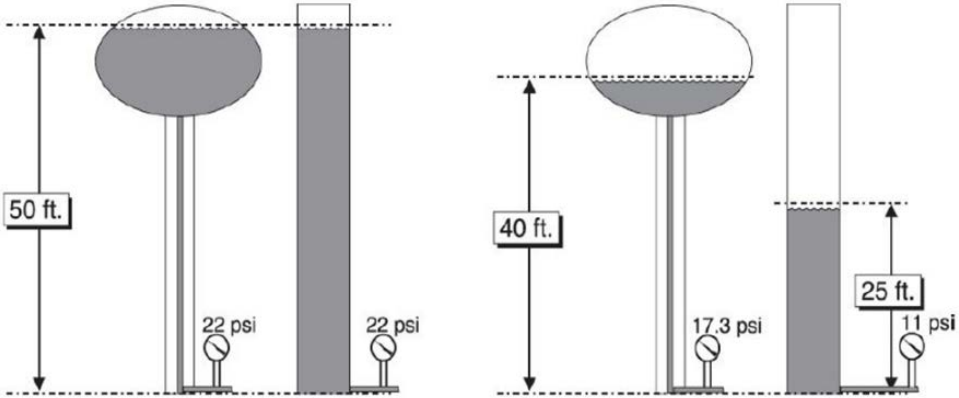
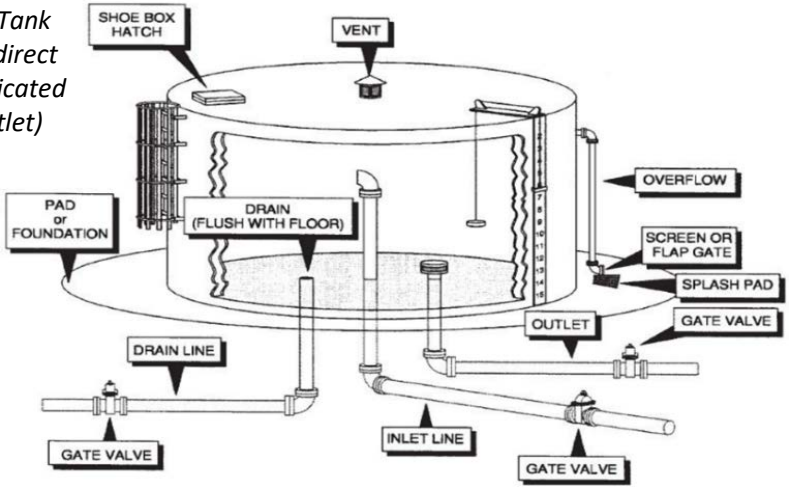


Figure 10-4: Tank components direct pumping (dedicated inlet and outlet)



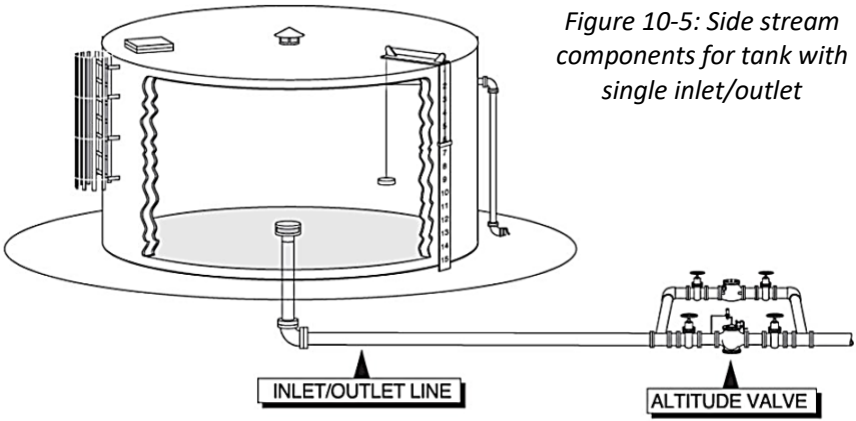


Figure 10-5: Side stream components for tank with single inlet/outlet

10.2 Hydropneumatic Storage Tanks

- Is tank capacity adequate?
- Does the low pressure "pump-on" level maintain adequate distribution system pressure?

Tank Capacity Formula

Tank capacity = at least 10 times capacity of the well's largest pump; and,

Well pumps = at least 10 times average daily consumption rate.

- Are instruments and controls adequate and operational? Does the operator use and maintain them?
- What is the cycle rate and air-to-water ratio?
- Does the operator properly protect the tank and the controls?
- Are emergency procedures established?
- Are there back-up systems?

- Are the interior and exterior surfaces in good condition?
- Are tank supports adequate and structurally sound?
- Is the recharge air free of pollutants such as oil from an air compressor?
- What is the physical condition of the outside hatch?
- Are the pump and source capable of meeting the PWS's maximum momentary demand?

CAUTION: Hydropneumatic tanks are pressure vessels. A pressure of 50 psi is equivalent to 3.5 tons per square foot of tank surface area. DO NOT TAP ON THE TANKS!

Figure 10-6: Styles of pressure tanks

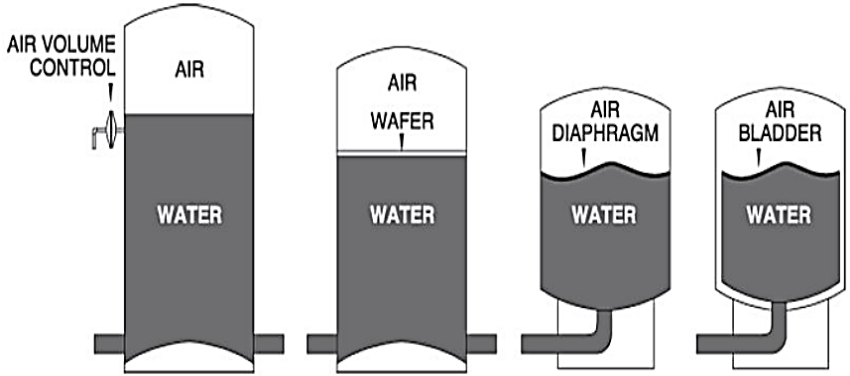
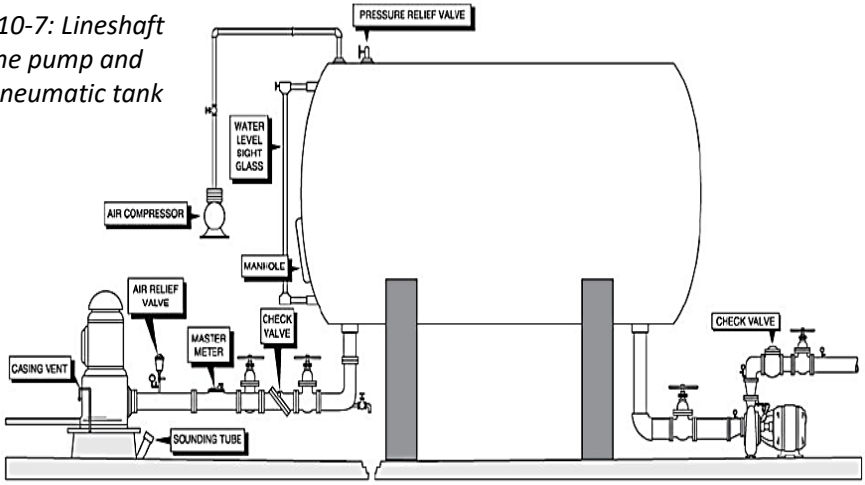


Figure 10-7: Lineshaft turbine pump and hydropneumatic tank



10.3 Possible Significant Deficiencies for Storage Facilities

- Access hatches not locked or hatch improperly designed (shoebox lid with intact seal).
- Holes left in tank by removal of cathodic protection rods or any other reason.
- Missing or damaged screen on air vents or overflow outlets. Overflows with flapper covers should still have a screen since debris, ice, snow, etc., can prevent them from closing.
- Erosion around the foundation of storage tanks which could lead to instability and eventual collapse of the tank (elevated or ground storage).
- Cracks in the walls of concrete storage facilities.
- Inadequate venting or missing air vents. No or improper screening of vents; vents do not terminate adequate distance above the surface.

- Evidence of animals, insects in the storage facility, or signs of tampering.
- No regular inspection, cleaning, or preventive maintenance schedules.
- Exterior corrosion or damage on hydropneumatic tanks.
- Inadequate site security.

11 Distribution Systems

11.1 Distribution System Components

- Does the PWS have an inventory of pipe material used?
- Are there materials of concern such as lead service lines, wood pipe, unlined cast iron, thin wall PVC, pipe not approved for potable water use?
- How many service connections are there? Does the PWS meter all service connections?
- Who owns the water meters?
- If the water meters on customer service lines are located in below grade vaults, who is responsible for maintaining the sanitary condition of the vault – the water system or the customer?
- How old are the water meters? Does the water system replace water meters at the frequency recommended by primacy agency or AWWA standards?

- Is there a main replacement program?
- Does the PWS have or follow standards for separation distances between potable water mains and storm or sanitary sewers?
- Are there any lead goosenecks still in place and used for service connections? If yes, how many? Are there plans to remove these? If yes, by what date?
- Does the PWS use HDPE pipe for main lines or service connections?

11.2 Material Standards

- What standards does management use to select materials? Are all materials ANSI/NSF certified?
- Does the operator only use materials manufactured according to industry standards such as AWWA and NSF?
- Is there a set of construction standards used by the PWS?
- Does the PWS have its own construction standards, or has it adopted some from another agency?
- Do the construction standards meet primacy agency requirements?
- Are in-house staff and contractors required to use the same standards?
- Does the water system follow their own standards?

11.3 Water Quality

- What disinfection procedure does the water system use for new or repaired water mains?
- Are distribution mains looped to the greatest extent possible?
- Has the addition of service connections created dead-end lines?
- Are there any bottlenecks in the piping system (a small diameter pipe connected on both ends by large diameter pipe)?
- Are blow-offs connected to sanitary or storm sewers, or do they exit below ground, below flood level in ditches or streams?
- Is there any point in the PWS where pressure drops below primacy agency pressure standards during peak demand or fire response?
- If the valves are in a vault, is the operator trained in confined space procedures?

- If there are pressure zones controlled by automatic pressure reducing valves (PRVs), do the PRVs work properly?
- If there are PRVs, can the operator describe how they work and what they do?
- What are the possible impacts of a PRV failure?
- If there is a hydraulic model, has the operator compared it to actual conditions? When was the model last updated?
- Are backflow prevention assemblies installed and tested at each commercial site where backflow could cause a reduction in water quality?
- Does the discharge piping on all air valves extend a proper distance above ground and flood level?

- Has management or the operator identified distribution system problem areas on a PWS map?
- Does the PWS provide bulk water stations? How are they monitored and controlled?

11.4 Maps, Drawings and Planning

- Are as-built drawings available?
- How often are maps updated?
- Do maps and as-builts contain the proper information?
- Is there a master plan showing proposed construction and replacement lines?

11.5 Distribution System Monitoring

- Have there been changes in the distribution system since the last survey?
- Does the operator have goals for and monitor for chlorine residuals throughout the distribution system?
- What is the operator using to measure disinfectant residuals?
- If required, is the residual at least 0.2 mg/L prior to the first customer?
- If required, does the operator maintain a measurable residual at coliform sampling points?
- Are there an adequate number of residual sampling sites, and do they provide a representative sample of PWS conditions?
- Does the operator use the correct, unexpired, reagent for testing free and total residuals?

- Is the operator waiting the correct length of time before reading disinfectant the residual?
- When has the operator last calibrated or replaced the testing instrument?
- Does the operator measure and record PWS pressures at high and low elevations?
- Does management record and analyze customer water quality complaints?
- If the PWS is fully metered, what is the percentage of total water produced that is considered to be non-revenue water?

11.6 Operation and Maintenance

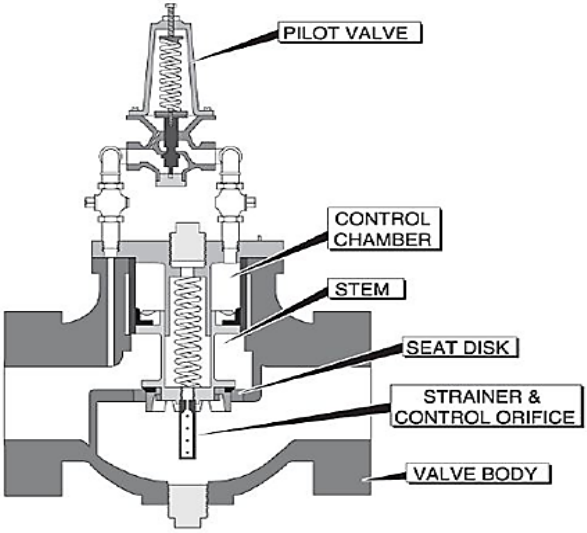
- What is the frequency of main breaks?
- Are the breaks primarily in one area? What type of pipe is involved?
- Is there a line flushing program? Is a systematic unidirectional process used? Are records maintained of frequency, location, and amount of time required?
- Is there a fire hydrant flushing program separate from the line flushing program?
- Is there a valve inspection and exercising program? Does the operator maintain the records?
- Does the PWS have a backhoe? If not, how long would it take a contractor or rental company to provide one if needed? Can the PWS obtain this equipment late at night?

- How often does the operator take pressure readings in the distribution system? Are they representative of the PWS? What readings result in action? What actions does the operator take?
- Are adequate repair materials on hand?
- Are there written procedures for isolating portions of the PWS and repairing mains?
- Does the PWS maintain an updated list of critical customers?
- Does the PWS have a corrosion control program?
- Does the PWS have an interconnection with any other PWSs?
- Does the PWS have adequate AND operable valves?
- Are all elbows, tees, and dead ends supported by concrete thrust blocks or restraining fittings?

- Is proper bedding used, and do contractors or maintenance staff follow proper backfill procedures during the installation of new or repaired pipes?
- Does the PWS or their contractors perform pressure or leak tests on all new pipe construction?
- If corrosive soils are present in the distribution system area, are cast-iron, ductile iron, and steel pipe protected from external corrosion?
- Are cast-iron and steel pipe protected from external corrosion?
- How does the surveyor's sanitary survey findings affect the RTCR sampling requirements?

Figure 11-1: Air release valves

Figure 11-2: Pressure control valve



11.7 Possible Significant Deficiencies for Distribution Systems

- Cross-connection(s).
- Negative or low pressures in the distribution system.
- Unapproved construction materials and methods.
- Lack of proper valving.
- Air release valves not plumbed to daylight.
- Inadequate pipe size for distribution needs.
- Not maintaining disinfectant residuals as required by either federal or state standards.

12 Cross-Connections

12.1 Cross-Connections

- Does the PWS have a written cross-connection control program?
- Is the cross-connection control program active and effective in protecting against cross-connections and backflow conditions?
- Does the cross-connection control program address areas of specific concern for cross-connection and backflow in the water system's service area?
- Are there any unprotected cross-connections at the water treatment plant?
- Does the PWS test backflow preventers at treatment plants and other facilities it owns?
- How are backflow preventers in the distribution system tested and maintained?
- Are there unprotected cross-connections in pumping stations?

- Are there unprotected cross-connections in the distribution system that the PWS owns or controls?
- Are new services reviewed for cross-connection hazard?
- Does the PWS have a program to control the use of fire hydrants?

Figure 12-1: Backflow as a result of back-pressure

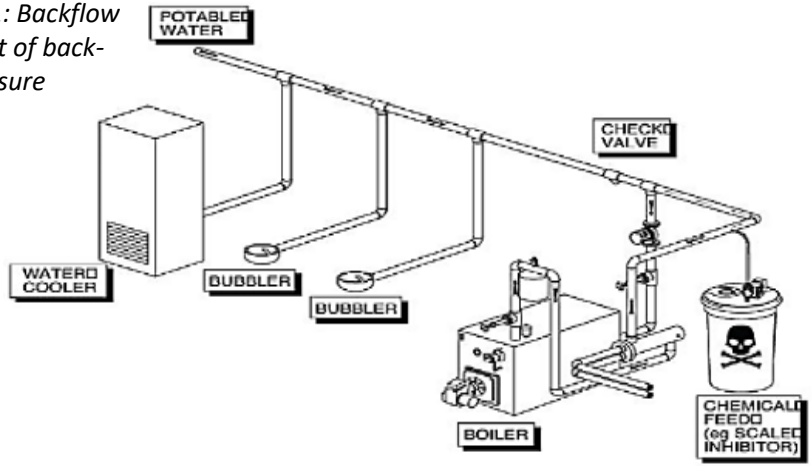


Figure 12-2: Indirect cross-connection

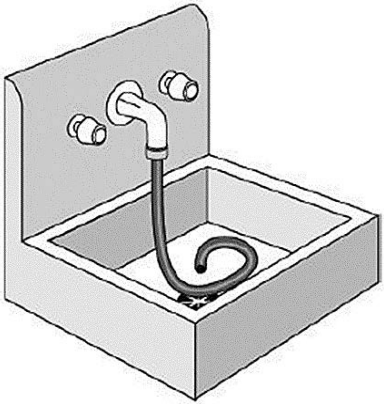


Figure 12-3: Air gap

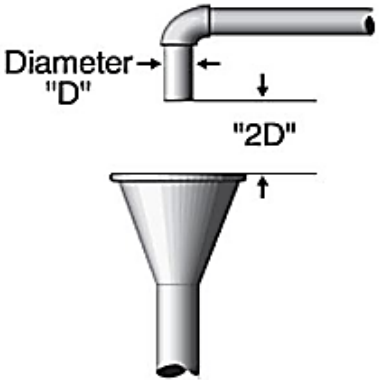


Figure 12-4: Atmospheric vacuum breaker

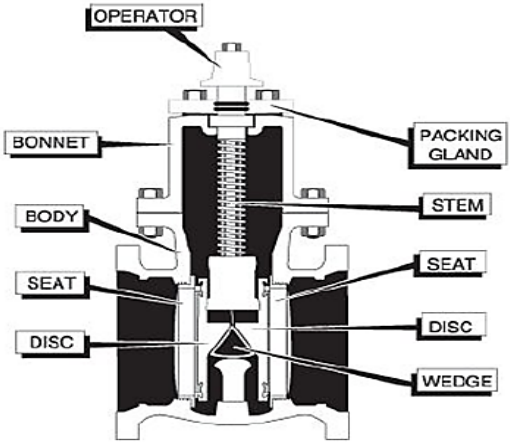


Figure 12-5: Gravity atmospheric vacuum breaker

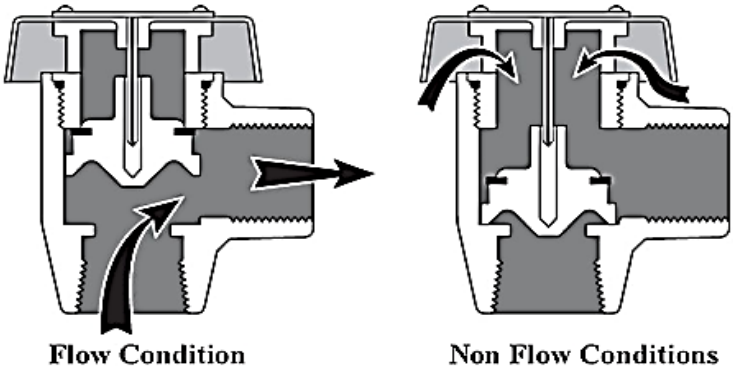


Figure 12-6: Pressure vacuum breaker

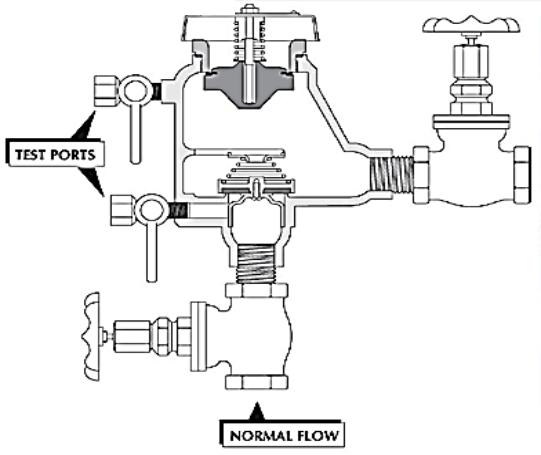


Figure 12-7: Double check valve assembly

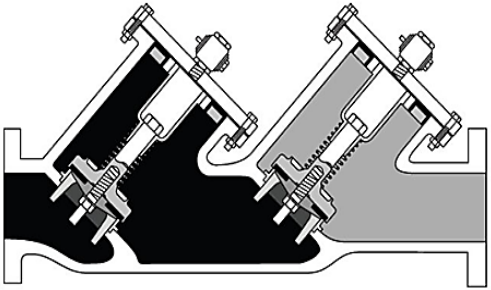


Figure 12-8: Reduced pressure principle backflow prevention assembly

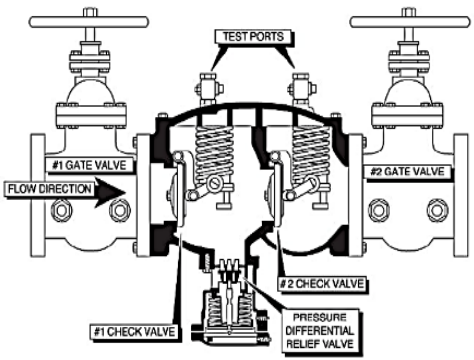


Figure 12-9: Split feed cross-connection diagram

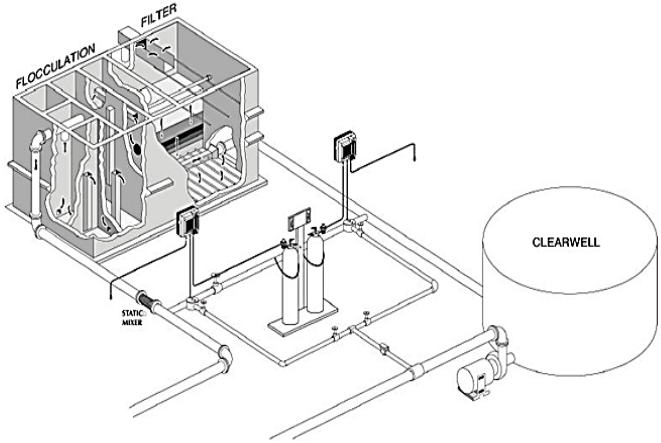
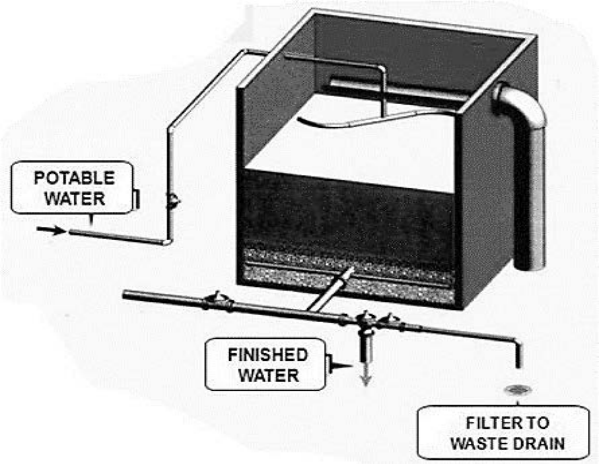


Figure 12-10: Surface wash cross-connection (potable surface wash water and unfiltered water)



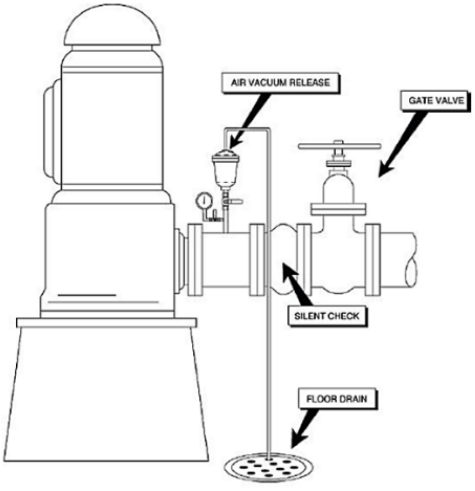


Figure 12-11: Air release valve piped to drain

12.2 Possible Significant Deficiencies for Cross-Connections

- Customers with private wells interconnected with premise plumbing.
- Hospitals, extermination businesses, industrial customers, etc., with no testable backflow prevention assemblies.
- Uncontrolled or unattended attachments to hydrants for use by water haulers.
- Backflow prevention assemblies are not tested, or no surveillance/enforcement program exists for usage and testing requirements (e.g., for home irrigation systems in addition to the usual businesses).
- High leakage rates that pose risks of back-siphonage during pressure drops (response to fires, main breaks, power outage, etc.).
- Pressure/air release valves located below grade in vaults or not separated from drains.

- No cross-connection program.
- Testable backflow prevention assemblies are not tested on an annual basis.
- Assemblies that fail the annual test are not repaired.
- New services not reviewed for cross connection hazards.
- Cross-connections between treated and untreated water.

13 Process Control and Compliance Monitoring

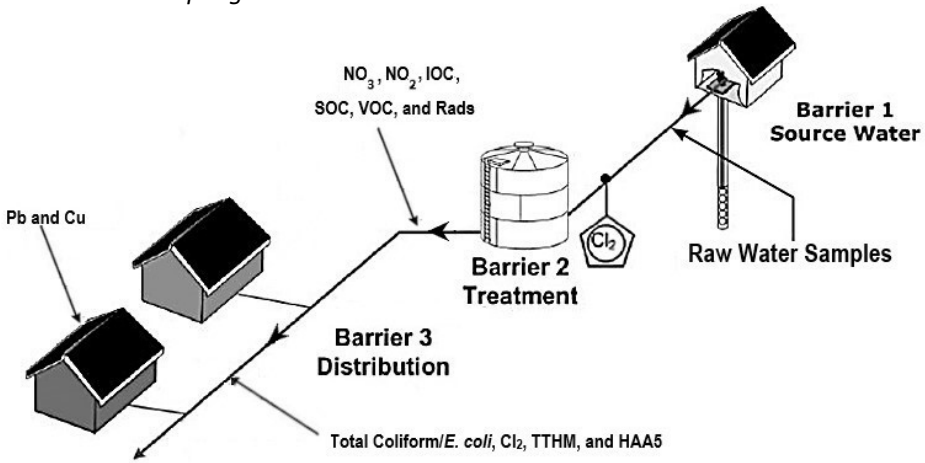
13.1 Approved Laboratories

- Is the laboratory certified for all the analytes being monitored?
- Is the laboratory certification current?

13.2 In-House Monitoring

- Is adequate monitoring in place?
- Is the operator following proper sample collection and analysis procedures?
- Are testing facilities and equipment adequate?
- Does the manufacturer recommend testing a “reagent blank” for each lot of reagent used in their colorimetric methods (including chlorine)?
- Does the operator properly maintain records of the monitoring program?
- Does the operator adjust treatment based on laboratory results?

Figure 13-1: Ground water systems sampling locations



13.3 Electronic Data Recording, Monitoring, and Testing: SCADA

- When was the current SCADA system installed?
- Did the operator receive adequate training and written guidance to operate and maintain the SCADA system?
- Can the operator contact the SCADA vendor when they cannot resolve an issue?

13.4 Possible Significant Deficiencies for Process Control Monitoring

- Using a laboratory or analyst for compliance samples not certified for drinking water analyses.
- Use of expired reagents.
- Use of incorrect sample containers to collect compliance samples (glass versus plastic, preserved versus unpreserved).
- Use of unapproved sampling site for compliance monitoring.
- Compositing of compliance samples instead of taking individual samples (unless allowed).
- Instrumentation not calibrated and verified according to manufacturer's operational manuals or state requirements.
- Failure to maintain a disinfectant residual log.

- If required, failure to continuously monitor and record turbidity from individual filters at least every 15 minutes.
- If required, failure to continuously monitor or collect grab samples every 4 hours for combined filter effluent turbidity.

14 Water System Management

14.1 Organization

- Who owns the PWS?
- Is there a formal organizational chart?
- Does the operating staff have authority to make required operation, maintenance, or administrative decisions affecting the performance and reliability of the plant or PWS?
- Are administrators familiar with SDWA requirements and PWS needs?
- Is there a formal and adequate planning process?
- Does the PWS manage its information?
- Does the PWS track and identify typical operating parameters such as non-revenue water and cost per unit of production of finished water?
- Does the PWS use a computer system to track finances, operational data, and maintenance practices?

- Is there effective communication between key management staff, operations staff, and the primacy agency?
- What is the level of cooperation between the PWS and other agencies and organizations?
- What is the level of cooperation between the PWS and the local fire department?
- Is there a customer complaint system and an ongoing public information program?
- Does the PWS have a budget and an adequate source of capital for operations, maintenance, and capital projects?
- Is the PWS eligible for, and has the PWS received, state or federal funding?
- Does the PWS have a budget and an adequate source of capital to fund staff wages?

14.2 Planning

- Is an emergency or contingency plan available, workable, and exercised?
- Are written, workable plans available for the areas listed below?
  - Source protection.
  - Sampling and monitoring.
  - Emergency or contingency.
  - Hazard communication plan (if required).
  - Cross-connection control.
  - Repair, replacement, and future expansion (capital improvement).
  - Distribution system flushing program.

14.3 Personnel

- Are there sufficient personnel?
- Is there anticipated staff separation within the next five years?
- Is there a contingency plan for replacing retiring or separating PWS personnel?
- Is the staff qualified?
- Does management ensure personnel are adequately and appropriately trained?
- Is complacency an issue?
- Does management adequately train the operators in safety procedures and equipment?

14.4 Operations

- Is there an overall O&M manual for the facility?
- Has management established standard operating procedures (SOPs) at the facility?
- Is there sufficient storage for spare parts, equipment, vehicles, traffic control devices, and supplies?
- Are the facilities and equipment of the PWS adequate?

14.5 Finance

- Does the PWS have the technical, managerial, and financial capacity to deliver safe water to its customers on a continuing basis? Are the financing and budget satisfactory? What is the estimated income? What are the estimated expenses?
- Does management properly prioritize funding?
- Are there sufficient funds for staff training?
- Are projected revenues consistent with projected growth?
- Does the PWS have formal accounting systems and written procedures for financial records?
- Does the PWS have budget and expenditure control procedures?
- What are the PWS's debt service expenses?
- Does the PWS have a water conservation policy or program?

14.6 Possible Significant Deficiencies for Water System Management

- Ongoing, unaddressed violations.
- Non-compliance with corrective action plan for significant deficiency identified in the last sanitary survey.
- No or inadequate SOPs.
- Insufficient staffing or coverage.
- Key managers unfamiliar with the SDWA requirements.
- No tracking of assets.
- No equipment use logs.
- No annual budget.
- No asset management or capital improvement plans.

15 Other Considerations

- Has the water system identified and implemented techniques and practices for its sustainability?
- Are water conservation and efficiency of water-using products key factors in ensuring water availability?
- Do customers have information on efficient water-using appliances?
- Has the water system conducted an energy audit?
- Can the water system separate its energy costs from other operating costs?
- Has a water supply analysis and water supply plan with demand projections been done?
- Are the sources of supply adequate to meet current and expected demand?

- Are there long-term changes in source water quantity or quality expected and plans to address any changes?
- Is there a drought response plan?