


General Exam Training (DEP Modules)

Drinking Water Plant Operator Certification Training

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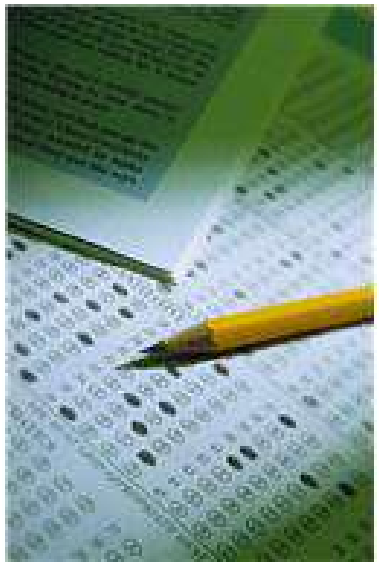
General Overview

- This general overview is to help operators prepare for the Part 1 General Water Treatment Examination.
- Excerpts have been compiled from various modules to assist learning.



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Modules Included

- ✓Module 1 – Public Water System Responsibilities
- ✓Module 2 – Ground Water Sources
- ✓Module 4 – Water Quality and Characteristics
- ✓Module 29 – General Chemistry
- ✓Module 5 – Disinfection and Chlorination
- ✓Module 10 – General Maintenance
- ✓Module 8 – Distribution Systems
- ✓Module 30 - Safety

Unit 1 Objectives

- Describe the responsibilities of the water supply facility and the treatment plant operator.
- List the 5 drinking water treatment objectives.
- Describe three important historical achievements in water treatment that link contaminated water to disease.

Examples of Contaminants

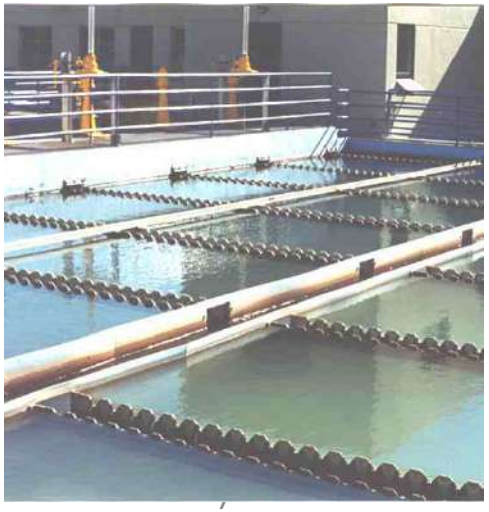
Contaminant	Type	Natural/Man Made
Iron	Chemical	Natural
Cryptosporidium	Biological	Natural
Clay particles	Suspended	Natural
MTBE	Chemical	Man made
Nitrates	Chemical	Usually man made
Legionella (a virus)	Biological	Natural
Fluoride	Chemical	Natural

Job of the public water supplier

The job of the public water supplier is to provide a clean, safe, and reliable supply of water at a reasonable cost.

Job of the water treatment operator

The water treatment plant operator is ultimately responsible for the quality and safety of the treated water leaving the water treatment plant



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Operator must:

- Be aware of the raw water quality
- Understand the treatment process
- Monitor the quality of the water at various stages of the treatment process.
- Monitor the quality of the treated water leaving the plant
- Ensure water treatment plant facilities are maintained in a safe and operable condition.
- Ensure reliable production and delivery of water to the distribution system.

Water Treatment Objectives

- Remove turbidity (suspended) material.
- Reduce concentrations of chemical contaminants to permissible levels
- Remove or inactivate pathogenic protozoans, bacteria, and viruses.
- Produce water that is clear, with no objectionable colors, odors or taste.
- Produce water that is chemically stable, and is not corrosive to metal piping and fixtures

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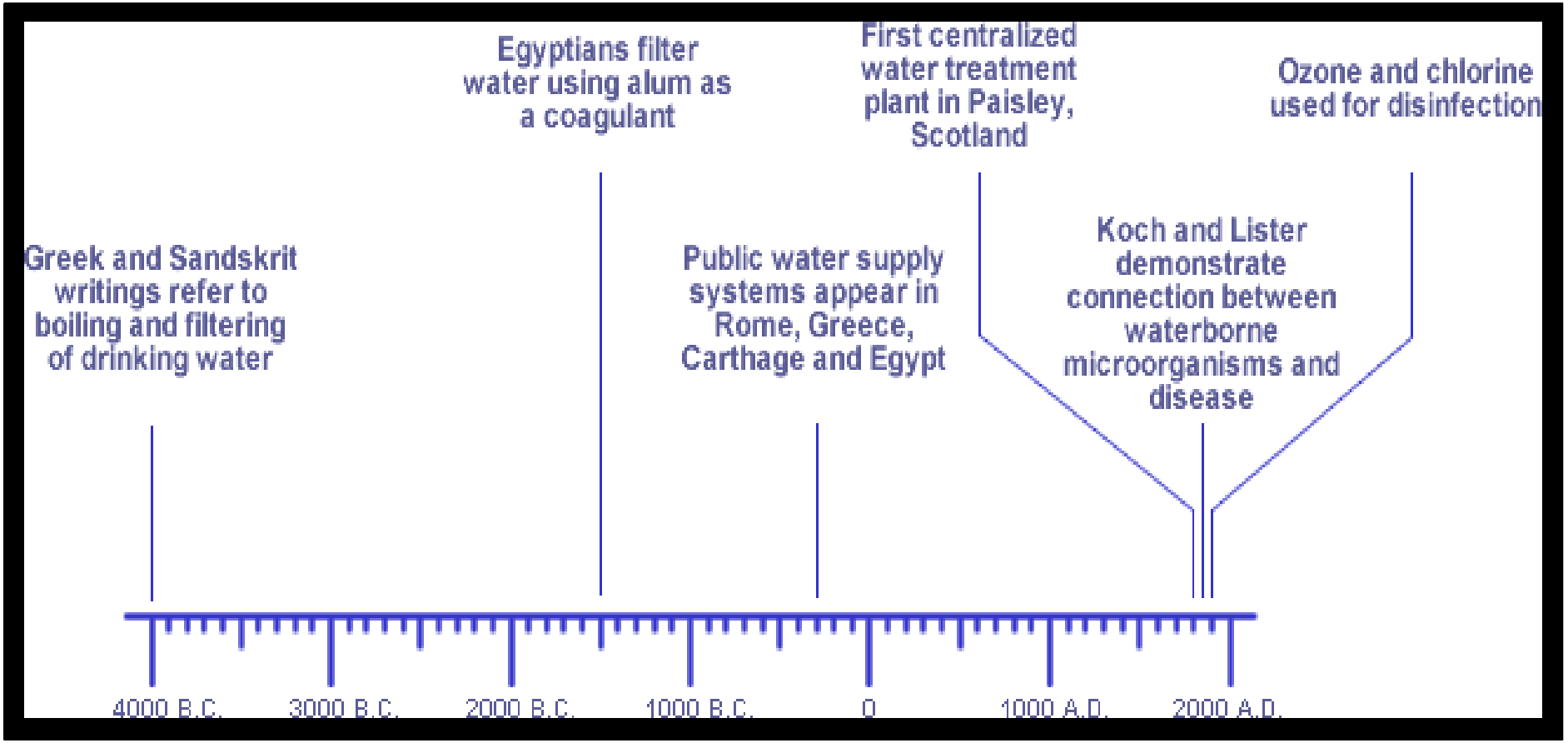
Figure 1.1: Timeline of Significant Developments



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Unit 1 Key Points

- See page 1-6, Module 1

Unit 2 – Public Water Supplies

Learning Objectives

- Describe the three different classifications of water systems and an example of each.

Public Water System

"A system for the provision to the public of water for human consumption through pipes or other constructed conveyances, if such system has at least fifteen service connections or regularly serves an average of at least twenty-five individuals daily at least 60 days out of the year".

Community versus Non-Community

1. A hospital has its own private well and water treatment system.
   - ANS: NTNCWS because it employs 25 of the same people at least 6 months out of the year.
2. A farmer has a good spring on his property and provides drinking water to 16 of his neighbors, free of charge.
   - ANS:CWS because it has 16 service connections.
3. A real estate developer drills a well and provides the water to 17 homes in the development.
   - ANS: CWS because it has 17 service connections.
4. A restaurant with its own well supply has an apartment above that's connected to the restaurant's plumbing system.
   - Ans: TNCWS because the restaurant serves a transient population.
5. A campground has sites with camper trailers set up permanently.
   - Ans: TNCWS because the people are probably not staying year round or even 6 months of the year.

Unit 2 Key Points

- ✓See Page 2-6 in the workbook

Unit 3 – Federal and State Regulations

Learning Objectives

- State the roles of federal and state agencies regarding drinking water.
- Identify key regulations that directly affect the water treatment plant operator.
- Explain the requirements for becoming and maintaining operator certification
- Identify the maximum contaminant levels, and monitoring and reporting requirements for regulated contaminants.

Who makes the rules and enforces them?

- **United States Environmental Protection Agency**
- **Department of Environmental Protection**
- **Pennsylvania has two River Basin Commissions:**
  - Susquehanna River Basin Commission (SRBC)
  - Delaware River Basin Commission (DRBC)

Operator Certification Act

- The purpose of the operator certification regs is to protect public health, safety and the environment.
- State Board of Certification of Water and Wastewater Systems Operators and the Pa. DEP sets the training, experience and examination standards for operator certification.

Definitions

✓An **appropriately certified operator** is an operator who holds a certificate of the same or higher class with all the subclasses of the system at which they work or want to work.

✓A **process control decision** is any decision that changes or maintains water quantity or water quality of a water or wastewater system in a manner that may affect public health or the environment.

SOPs

Uncertified and not appropriately certified operators can make process control decisions ONLY WHEN:

- Under the direction of an appropriately certified operator
- Using SOPs that were developed by an appropriately certified operator.
  - An appropriately certified operator must be *available* at all times during system operations.

Certification Requirements

- Education Requirement
- Examination Requirements
- Criminal History Check
- Experience Requirement

Final **official approval by the Board** and awarded a certificate of a class and subclass(es) commensurate with your experience. Final approval will be granted after a thorough review of the applicant's information.

Table 3.1: Experience Requirements

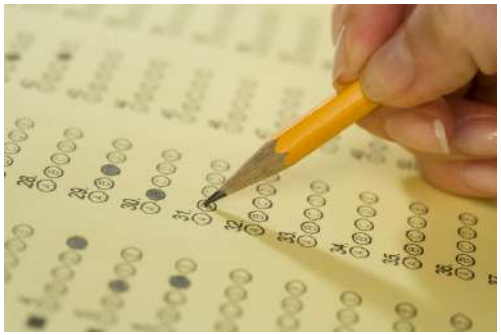
	MINIMUM OPERATING EXPERIENCE TO BECOME CERTIFIED				
CLASS	**High School Diploma or GED**	**DEP Approved Certificate Program in Water or Wastewater**	**DEP Approved Associates Degree Program in Water or Wastewater**	**Associates Degree in Env'l or Physical Sciences or Engineering**	**BS/BA Degree in Biology, Chemistry, Env'l or Physical Sciences, or Sanitary or Env'l Engineering**
A	4 Years	2 Years	1 Year	3.5 Years	2 Years
B	3 Years	1 Year	6 Months	2.5 Years	1 Year
C	2 Years	6 Months	6 Months	1.5 Years	6 Months
D	1 Year	6 Months	6 Months	6 Months	6 Months
E	1 Year	6 Months	6 Months	6 Months	6 Months
Dc	6 Months	0	0	6 Months	0

Operator Experience

1. Operation of mechanical equipment,
2. Maintenance of mechanical equipment,
3. Collection of samples,
4. Analysis of chemical and biological samples,
5. Performing calculations related to process control,
6. Preparing or standardizing chemical and biological solutions,
7. Compiling and completing monitoring data, determining appropriate process control measures

2-Part Examination

- Part I: General Exam
- Part II: Treatment technology specific



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Water system classes and subclasses

- If you have treatment other than disinfection you cannot be classified as a Dc.
- An operator must be certified in both the **class and subclasses** of the treatment plant they are operating.

Table 3.2: Continuing Education

Operator Certification Class	Minimum Number of Samples Required per Month
A	30
B	30
C	30
D	15
E	15
Dc	9
Dn	6

Certified Operator Responsibility

The board may revoke, suspend or modify a certificate if it is found an operator has been:

- Negligent
- Committed fraud
- Falsified an application
- Falsified operating records
- Failed to use reasonable care
- Failed to use reasonable judgment

Certified Operators must:

- Meet all the requirements for recertification.
- Report to the system owner any know violation or system condition that may be or are causing violations of any department regulation or permit condition.
- Providing for the suitable O&M of a water system utilizing available resources to comply with all laws.
- Making or implementing process control decisions, or directing actions related to process control decisions for specific water systems.

Owners must:

- Employ, identify and report to the department the names of available operators required by DEP.
- Require, supervise and direct certified operators to take such action so that the water system is in compliance with all laws.
- Providing a copy of permit conditions to the certified operator in responsible charge.

Vocabulary

Safe Drinking Water Act establishes maximum contaminant levels (MCL's) for various contaminants that may be found in drinking water. These standards are divided into:

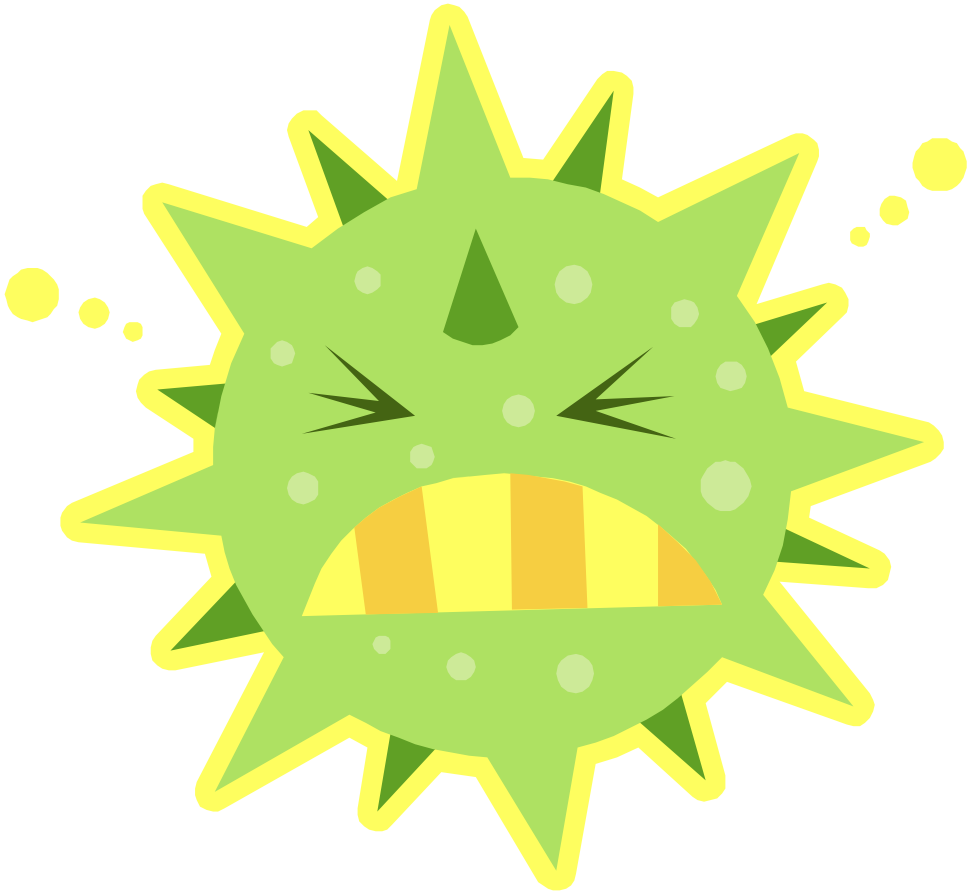
- **Primary Standards**
- **Secondary Standards**

Other Relevant Federal Regulations

- **Surface Water Treatment Rule**
- **Groundwater Rule**
- **Interim Enhanced Surface Water Treatment Rule**
- **Long Term 1/2 Enhanced Surface Water Treatment Rule**
- **Filter Backwash Recycling Rule**
- **Stage 1 Disinfectants and Disinfection Byproduct Rule**
- **Stage 2 Disinfectants and Disinfection Byproduct Rule**

More Regulations

- **Groundwater Rule**
- **Total Coliform Rule**
- **Arsenic Rule**



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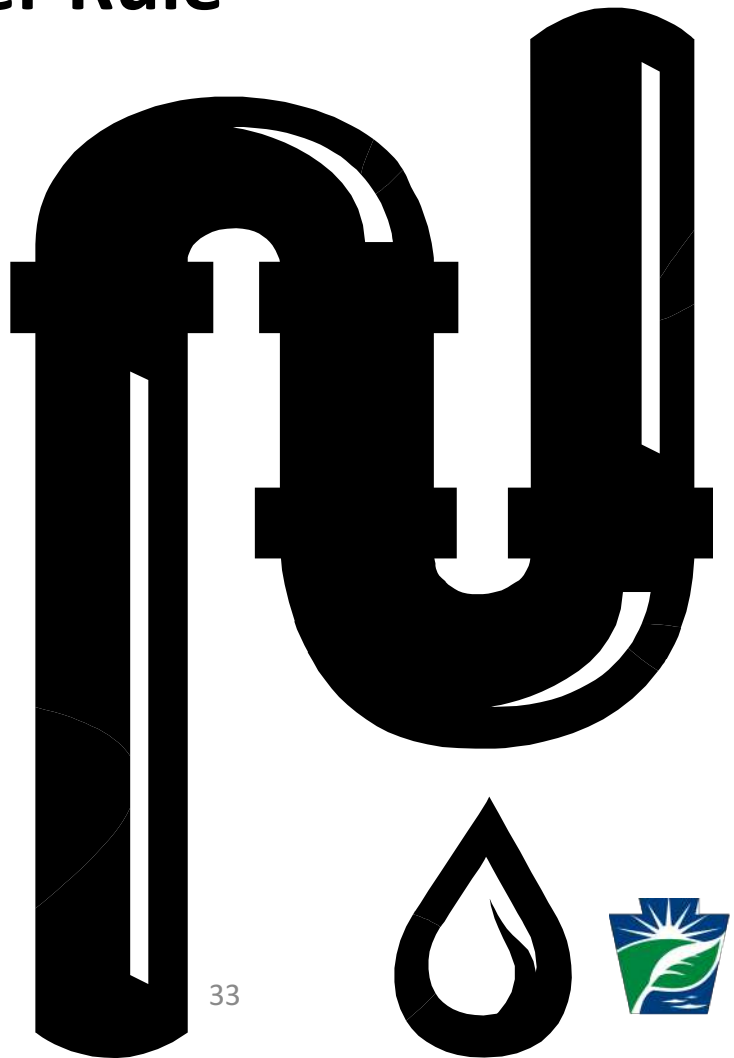
Last Regulation

Lead and Copper Rule



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PA Water Supply Manual

Seven Sections:

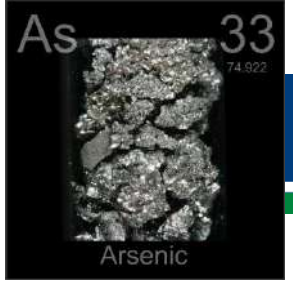
- Summary of Key Requirements
- Community System Design Standards
- Non- Community System Design Standards
- Bottled Water, Bulk Water Hauling, Water Vending Machines, and Retail Water Facilities
- Operations and Maintenance
- Emergency Response
- Cross-Connection Control/Backflow Prevention

Microbiological

- Monitored monthly (# based on population)
- Samples collected in distribution system
- Acute violations (Table 3.3)

	Total Coliform	Fecal or E. coli
Routine Sample	+	+
Associated Check Sample	+	

	Total Coliform	Fecal or E. coli
Routine Sample	+	
Associated Check Sample	+	+



Inorganic Chemicals

- One annual sample (surface water sources) or one sample every three years (groundwater sources) is required
- Samples are taken from each point water enters the distribution system.

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Organics: VOCs and SOCs

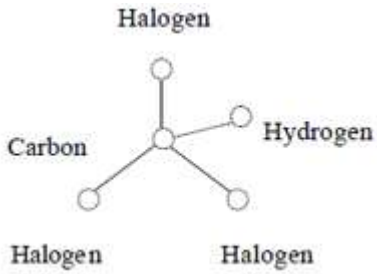
1. One annual sample is required
2. Samples are taken from each point water enters the distribution system.

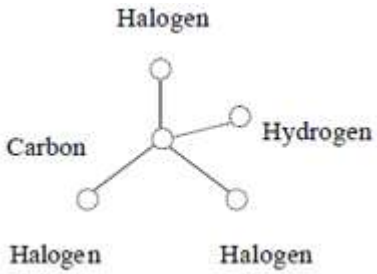
Nitrate/Nitrite

- One annual sample is required,
  - Or quarterly samples for at least 4 consecutive quarters if initial sample is over 50% of the MCL.
- Samples are taken from each point water enters the distribution system.

Disinfection Byproducts

- Sampling requirements for TTHM's and HAA5 vary according to source type and population served.
- Sample are taken from the locations within the distribution system that are likely to cause high levels of TTHMs and HAA5s.
- A system has exceeded the MCL if the locational running annual average of any site exceeds the MCL.





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Radionuclides

- Level is based on an annual composite of four consecutive quarterly samples (for surface water systems) or one sample every four years (for groundwater systems).
- Samples are taken from the distribution system.

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Turbidity (filtration)

- Effluent turbidity of individual filters must be monitored continuously. The turbidity of the combined effluent flow from all filters must be sampled at least every 4 hours.
- ***Important:*** What qualifies as MCL exceedances listed in workbook on 3-21

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Disinfectant Residual

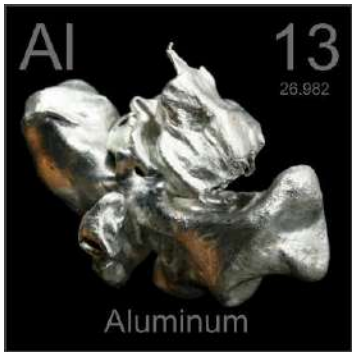
- Disinfectant residual must be monitored continuously except for groundwater systems serving 3,300 or fewer people.
  - <3,300 take a daily grab sample
- Surface water systems have specific minimum residual levels
  - Other systems must have detectable levels of residual in distribution

Lead and Copper

- A system has exceeded the MCL if the 90th percentile value of the samples exceeds the action levels for lead or copper.
  - The action levels for lead and copper are 0.015 mg/L and 1.3 mg/L

Secondary Contaminants

The secondary contaminants most commonly monitored by the water treatment plant operator include **color, corrosivity, aluminum, chlorides, iron, manganese, odor, pH, and total dissolved solids.**



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Public Notification

- 1-hour reporting for:
  - All Tier 1 violations and situations
  - Most Tier 2 violations or situations
  - Any sample that requires a check sample

- Tier 1 and Tier 2 definitions

Public Notification – Cont'd

- Tier 1 Violations (3-23 and 3-24)
  - Common Tier 1: Violation of MCL total coliforms when fecal or E. Coli are present

Public Notification – Cont'd

- Tier 2 Violations (3-24 and 3-25)
  - Please note that secondary contaminants are a Tier 2
  - Also note: total coliform without E. coli/Fecal is Tier 2.

Public Notification – Cont'd

Table 3.4: Public Notification Delivery Deadlines		
Tier	Deadlines for Notice	Deadlines to Contact DEP*
1	24 hours	1 Hour
2	30 days	1 Hour for MCL, MRDL,TT Violations
3	1 year	Not required

Unit 3 (Regulations) Wrap-Up

- **Exercise: Page 3-27 in the workbook**
- **Key Points: Page 3-29 in the workbook**

Unit 4: System Management Responsibilities

Learning Objectives

- Identify the major system management responsibility topics and provide links to templates.
- Identify additional drinking water resources.

Tables

This unit includes tables that summarize selected system management responsibilities

- Total coliform sampling siting plan
- Lead and copper rule sample siting plan
- Stage 2 Disinfectant Byproduct Rule Monitoring Plan
- Monthly Operation Reports
- Complaint Record
- Operation / Maintenance Plan
- Emergency Response Plan
- Distribution System Map
- Cross Connection Control Plan
- Sanitary Survey
- Record Retention

Unit 4 Key Points

- Use the numerous tables in this unit to review your system management responsibilities under chapter 109
- Use the templates for the various plans if you have not yet created these plans
- Table 12: Additional Resources provides you with links to many important DEP web pages
- Systems that serve more than 3,300 people must conduct a vulnerability assessment to address terrorist threats

Groundwater Sources of Supply and Protection

Volume II, Module 1

- Unit 1 – Introduction to Groundwater
- Unit 2 - Aquifers

Sources of Groundwater for Drinking

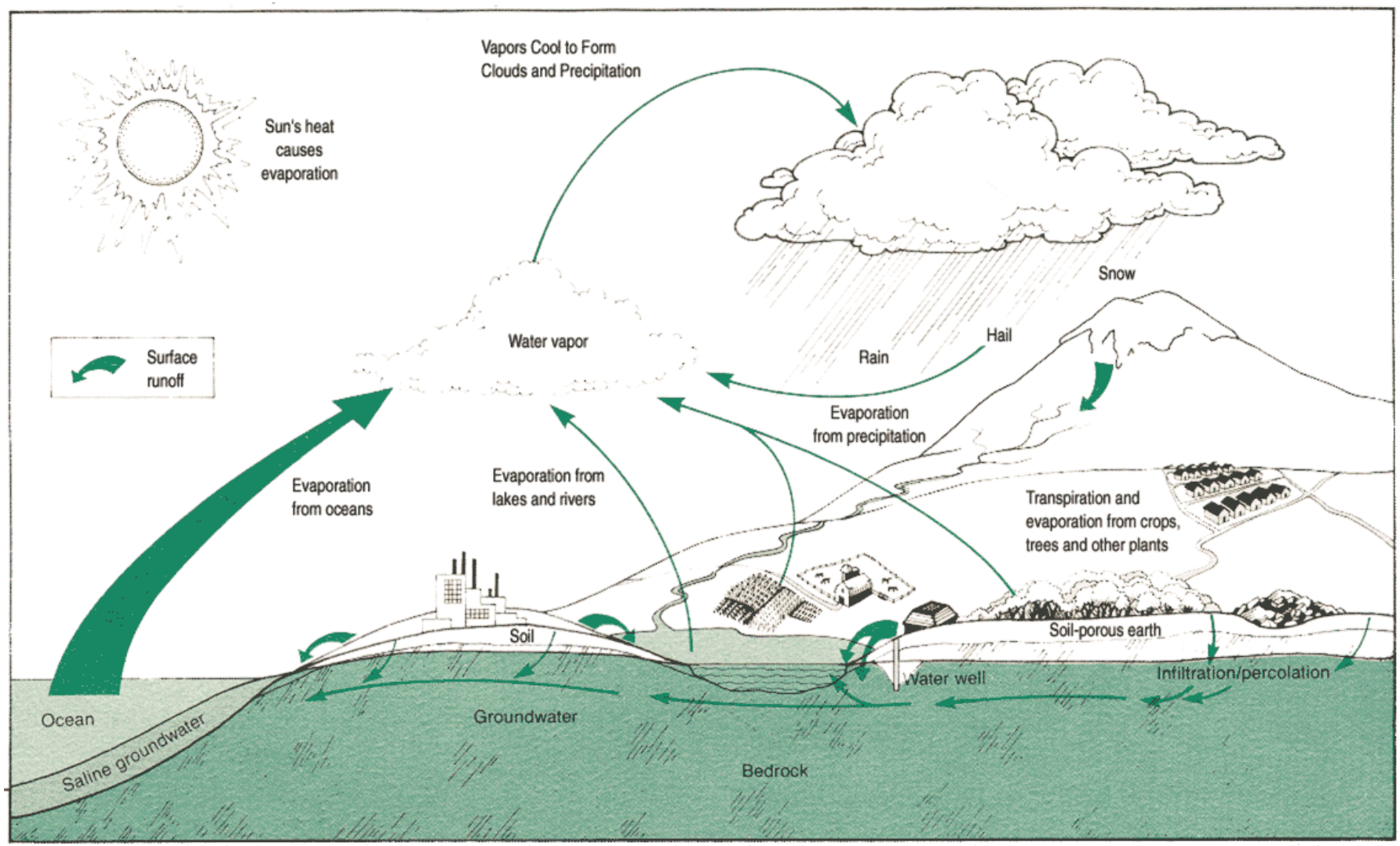
- Water obtained from dug, drilled, bored, jetted or driven wells
- Water obtained from Infiltration Galleries and Radial Collectors
- Water obtained from springs

GUDI

Groundwater **U**nder the **D**irect **I**nfluence of water that has been classified as a surface water source.

- Requires treatment as surface water.

Hydrologic Cycle



Unit 1 (Intro to GW) Wrap-Up

- Exercise on Page 1-11 of Volume II workbook
- Key Points on Page 1-12 of Volume II workbook

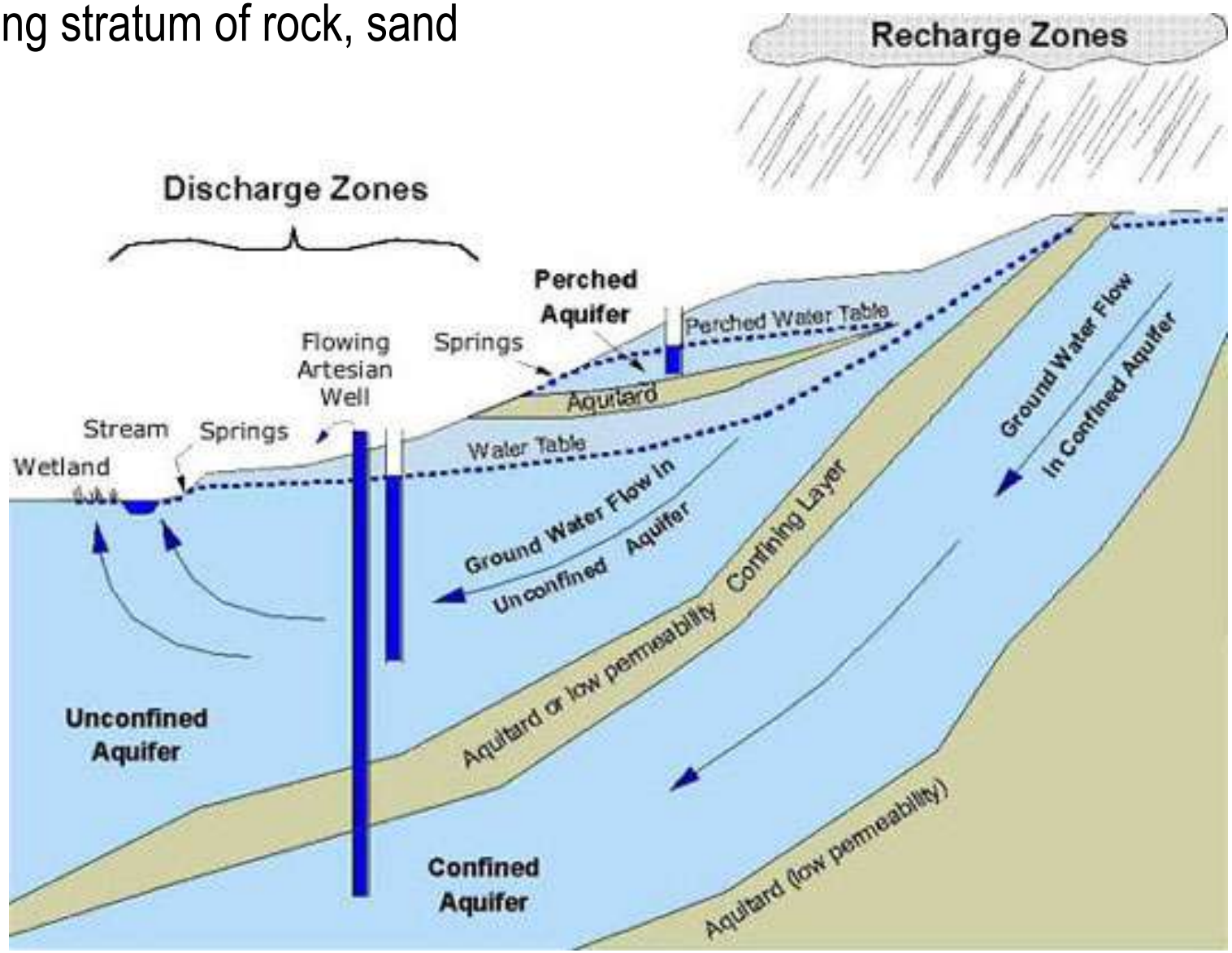
Module 2, Unit 2 - Aquifers

Objectives

- List four types of groundwater aquifers found in Pennsylvania
- Identify on a map, the location of Pennsylvania's principal groundwater aquifers.
- Describe the geology of each of the four aquifers.
- List three common types of groundwater sources found in Pennsylvania.

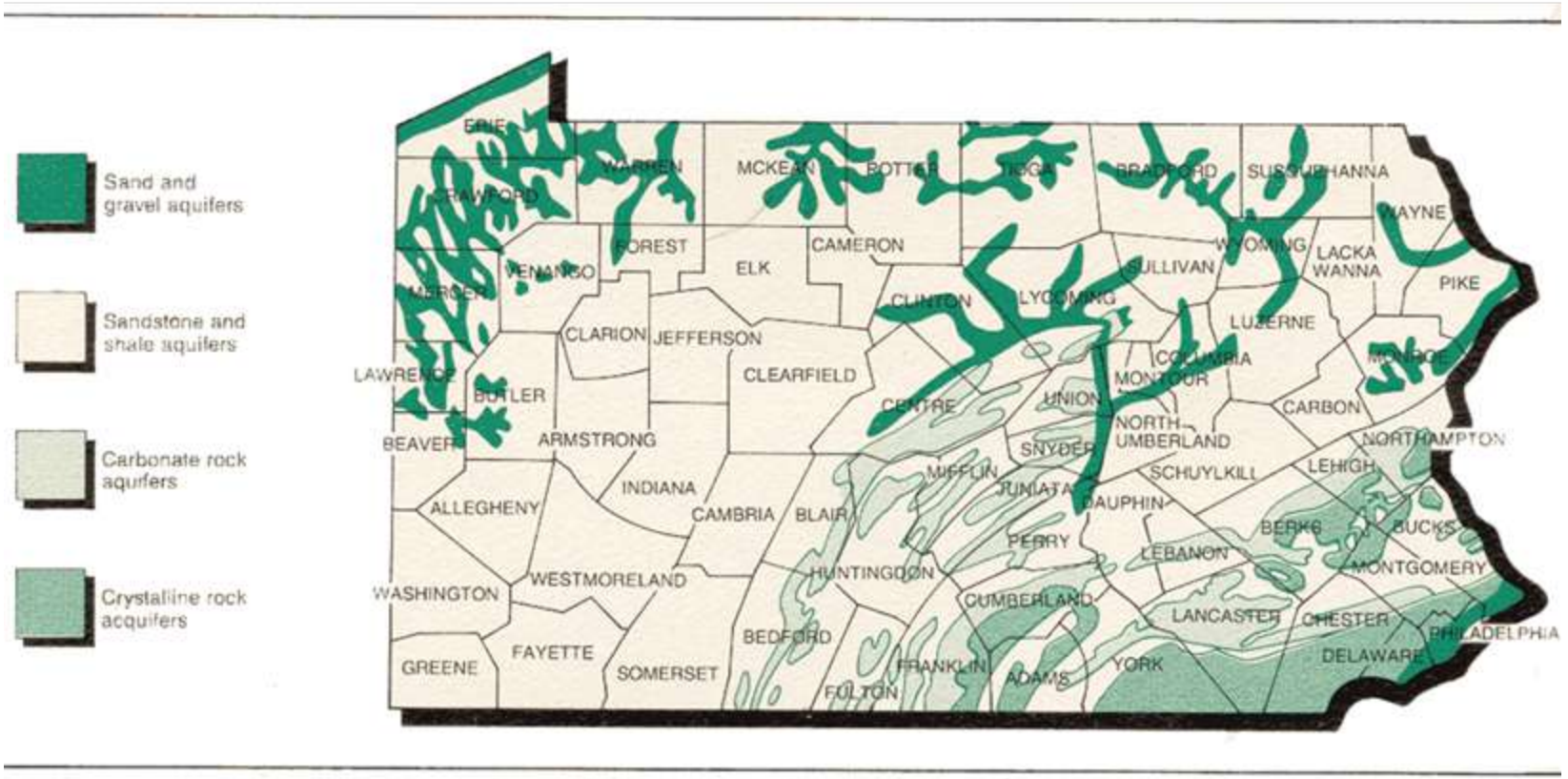
Aquifer

A water-bearing stratum of rock, sand or gravel



Types of Aquifers

- Pages 2-2 to 2-8 in workbook



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Types of Groundwater Sources

- Types of wells
- Springs
- Infiltration Galleries

Unit 2 (Aquifers) Wrap-Up

- Exercise: Page 2-12
- Key points: Page 2-14

Unit 3: Water Quality Classifications

Physical Characteristics

I. Microorganisms

II. Inorganic Constituents

III. Organic Compounds

IV. Radionuclides

V. Disinfectants and Disinfection Byproducts

Regulated Waterborne Micros

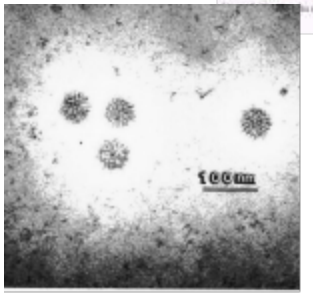
Microorganism/Indicator	Regulation	Goal
Cryptosporidium	TT	Zero
Giardia lamblia	TT	Zero
E. coli	TT	Zero
Fecal coliforms	TT	Zero
Legionella	TT	Zero
Viruses (enteric)	TT	Zero
Heterotrophic plate count (HPC)	TT	NA
Total coliforms	Max 5% of monthly readings positive	Zero
Turbidity	PS: < 0.3 NTU – 95% of readings; 1.0 NTU max	NA

TT = Treatment Technique

NA = Not Applicable

Categories of Micros

1. Bacteria
2. Protozoa
3. Viruses



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Microbial Indicators

- Microbial indicators used in place of testing for pathogens.
- Ideal microbial indicators should have the following characteristics listed on 3-13 (Volume II)

Inorganic Chemical and Treatment Terminology

- Page 3-19 and 3-20
- Page 3-23, Bring your attention to:
  - Hardness, Total: The presence of divalent metallic cations in water due to dissolution of minerals (primarily salts of calcium and magnesium) in geologic formations by natural waters.

Acute vs Chronic

"Usually, acute means sudden onset of a disease or injury whereas chronic diseases develop slowly and gradually. Acute condition happens when you cut yourself with a knife or catch a cold whereas chronic medical condition is when you suffer from pain and disease over an extended period of time."

The health effects listed on table 3-10 are primarily chronic.

Nitrates

- Infants below the age of six months who drink water containing nitrate and/or nitrite in excess of the MCL could become seriously ill (Blue Baby Syndrome)
  - Symptoms include shortness of breath and blue-baby syndrome.
- Acute Health Effect

Exercise - Inorganics

- Exercise on Page 3-18

Organic Compounds

- Man-made (Synthetic)
- Natural Organic Matter (NOM)

- *Organics Exercise on 3-34*

Rads and DBPs

- Types of Rads (pg 3-35)
- Disinfectants (Table 3-17):

Parameter	MRDL	MRDLG	BAT
Chlorine – mg/L as Cl_2	4	4.0	DC
Chloramines – mg/L as Cl_2	4	4.0	DC
Chlorine dioxide – mg/L as ClO_2	0.8	0.8	DC

Answers for Volume II Exercises

1. Water Table
2. By water dissolving portions of the carbonate rock
3. E. Coli, Cryptosporidium, Giardia lamblia, Fecal Coliform, Legionella, Viruses, Heterotrophic Plate Count, total coliforms, turbidity
4. True
5. Present in large numbers, Present in pathogenic microorganisms, High ratio of indicators, stable, absent in uncontaminated water, easily detectable
6. True
7. True
8. 4 mg/L
9. 0.005 mg/L
10. False

Key Points for Unit 3 – Water Quality Classifications

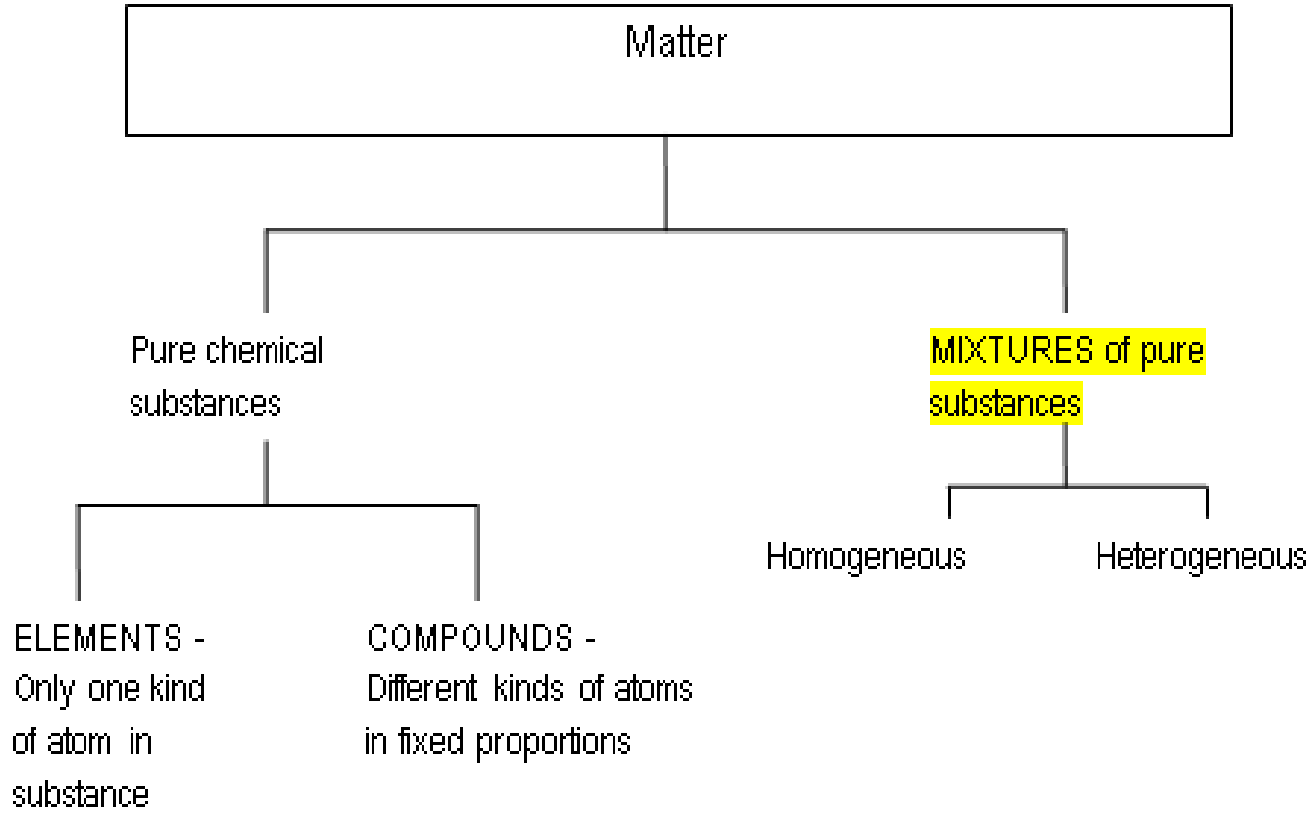
- See page 3-41

(Mod 29) Chemistry Concepts

Learning Objectives

- List three states of matter and explain the difference among them.
- List and define four physical properties of matter.
- Explain the difference between elements, compounds and mixtures.
- List the primary difference between a physical and a chemical change of matter.

Classification of Matter



General Chemistry Definitions

- **Density** is the mass of a substance per unit of volume of the substance.
- **Specific gravity** is the density of a substance compared to the weight of the same volume of water.

Example 1

Calculate the weight of a gallon of 50% NaOH (sodium hydroxide or caustic soda), given that a 50% solution of caustic soda has a specific gravity of 1.53.

Weight, lbs/gal = (Specific gravity of substance) x (weight of a gallon of water)

Weight, lbs/gal = (1.53) x (8.34 lbs/gal)

Weight = A 50% solution of NaOH weighs 12.8 lbs/gal

Example 2

What would be the weight of a 55 gallon drum of the coagulant Sternpac if the specific gravity of the product is 1.27?

Weight, lbs/gal = (Specific gravity) x (wt of a gal of water)

Weight, lbs/gal = (1.27) x (8.34 lbs/gal) = 10.6 lbs/gal

Weight = ONE gallon of Sternpac weighs 10.6 lbs/gal

So, 55 gallons = $\frac{10.6 \text{ lbs}}{\text{gallons}} \times 55 \text{ gallons} = 583 \text{ pounds}$

Example 3

Calculate the number of gallons of 2,000 pounds of 12% NaOCl (sodium hypochlorite), given its specific gravity of 1.12.

Weight, lbs/gal = (specific gravity of substance) x (weight of a gallon of water)

Weight, lbs/gal = (1.12) x (8.34 lbs/gal)

Weight = A 12% solution of NaOCl weighs 9.3 lbs/gal

Calculate the numbers of gallons of 2,000 lbs. of 12% NaOCl

(total weight lbs) ÷ (weight lbs/gallon) = gallons of 12% NaOCl

(2,000 lbs) ÷ (9.3 lbs/gal) = 215 gallons of 12% NaOCl

Class Exercises

1. *The specific gravity of Aqua Mag is 1.4. How much (lbs) does a one gallon weigh?*

   One gallon = 8.34 x 1.2 = 12. lbs

2. *How much does a 30 gallon drum of 60% fluorosilic acid weigh (lbs) if it has a specific gravity of 1.46?*

   30 gal drum = 8.34 x 1.46 x 30 = 365 pounds

3. *Your plant has a 10,000 gallon tank of Aluminum Chloride. The specific gravity of Aluminum Chloride is 1.2. How much (in pounds) does the tank of Aluminum Chloride weigh when the tank is full?*

   10,000 gal = 8.34 x 1.46 x 10,000 =100,000 pounds

Converting temperatures C/F

Formulas area given on the formula sheet!

$0.555\ (°F - 32) = °C$

$(1.8 \times °C) + 32 = °F$

Convert: 10 °C = ? **°F**

Problem Set Up and Calculation:

Step 1: Select correct conversion formula which is

°F = (1.8 x °C) + 32

Step 2: Insert known value of **10 °C** into formula

Step 3: Multiply within the parentheses (1.8 X 10) = **18**

Step 4: Add 18 + 32 = **50**

Module 29 Wrap Up

- Exercise on Page 4-9
- Key Points on Page 4-10

(Vol. III) Module 5: Disinfection

Learning Objectives

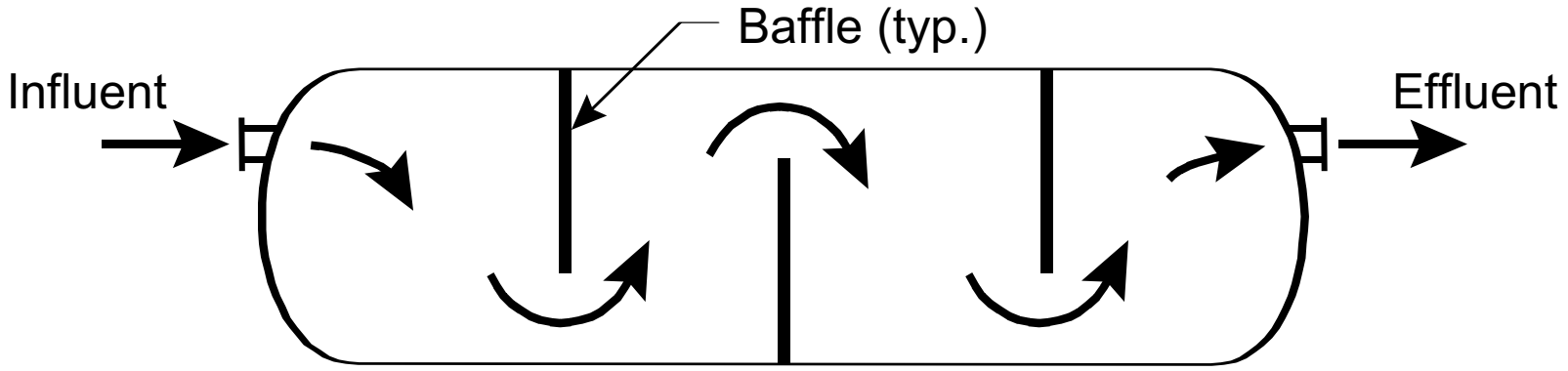
- Explain the general purpose and regulatory requirements of the disinfection process.
- List bacteria, viruses and intestinal parasites that contaminate drinking water.
- List factors that influence disinfection and explain how they influence it.
- List five types of chemical disinfectants and explain the advantages and disadvantages of each.
- Explain how irradiation is used as a disinfection process.
- List drinking water regulations and explain the reason for each regulation

Disinfection

For the most part, we will be focusing on the factors influencing disinfection.

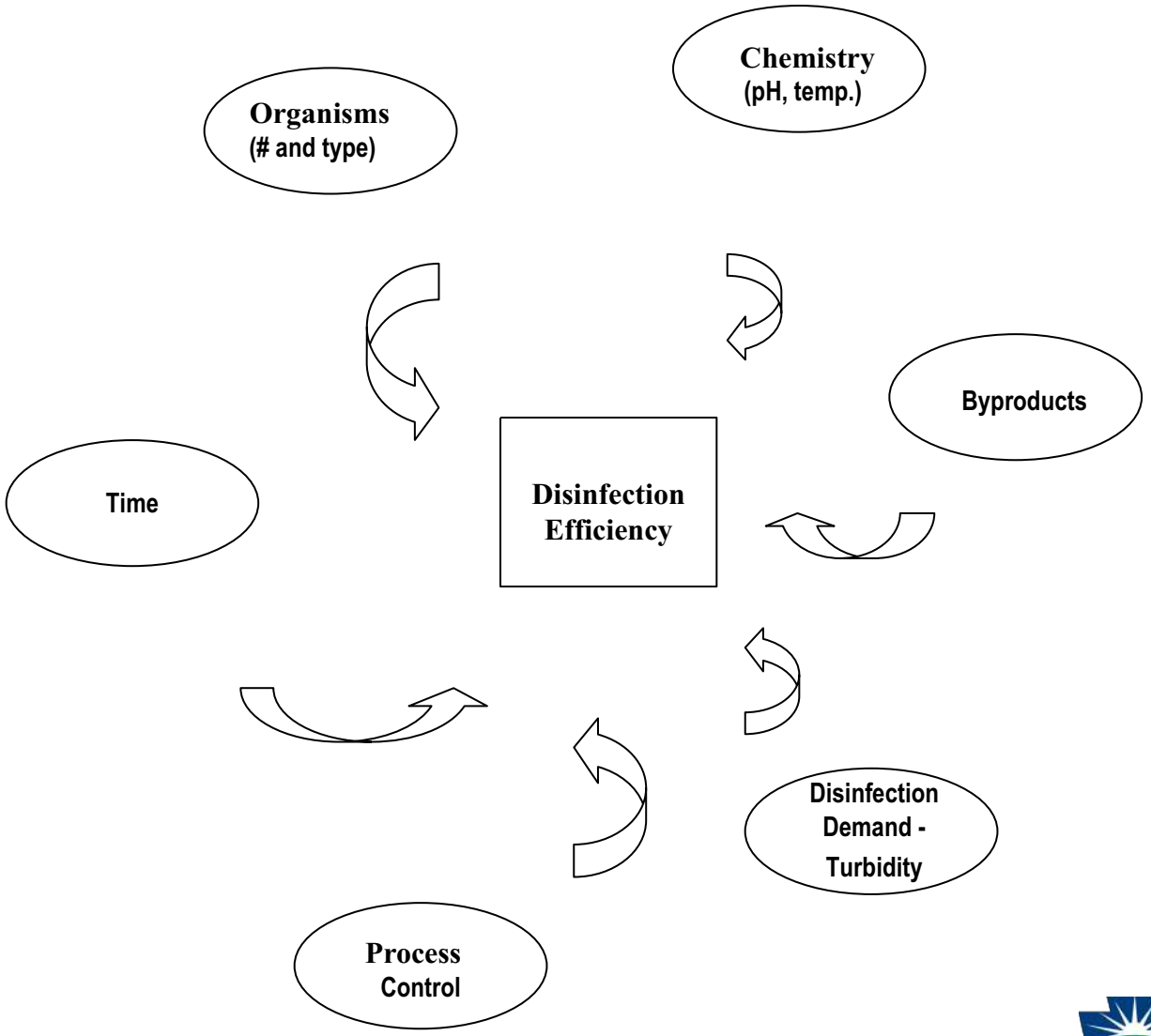
Minimum Treatment Disinfection

For **groundwater** wells, disinfection using chlorine or one of its compounds, followed by **20 minutes of detention time**, is required.



For surface water: Various forms of treatment required

Factors which influence disinfection



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Organisms

- The numbers and types of organisms could determine the type of disinfectant needed and the amount or dosage of that product.
- We use an indicator organism to determine the bacterial quality of the water.
- Coliform bacteria make good indicator organisms because:
  - They are always present when pathogens are present.
  - The testing method for detection is easy and reliable.
  - When they are absent, we can assume that pathogens are also absent.

Disinfection: Temperature

- Disinfection of water with free chlorine will be more efficient at temperatures greater than 60°F than at temperatures less than 60°F.
- Important to monitor chlorine residual throughout the disinfection process.

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Disinfection: pH

Disinfection of water with free chlorine will be more efficient at values **lower than 7.0** than at values greater than 7.0.

Lower pH, better disinfection

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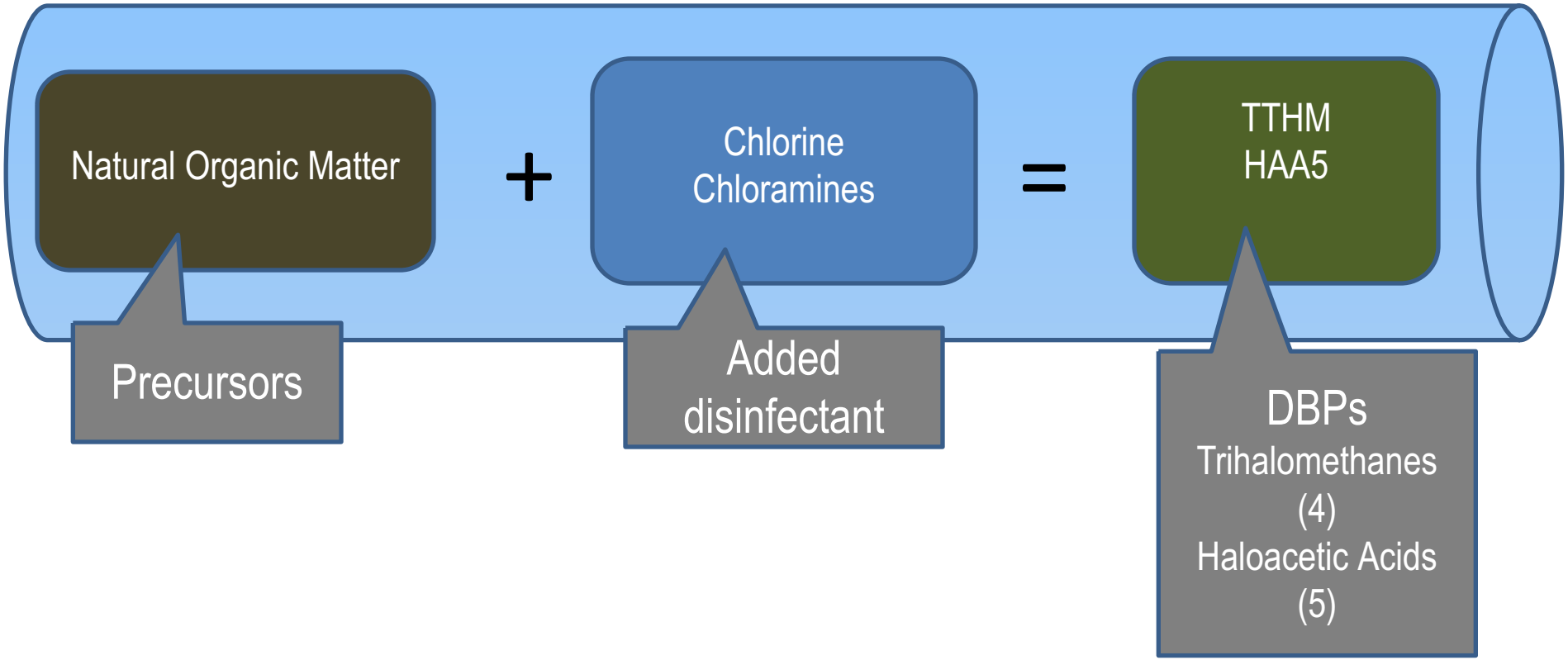
What are disinfection byproducts?

What are disinfection byproducts:



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Disinfection Demand

Anything in the source water that will react with the disinfectant and make it unavailable for disinfection.

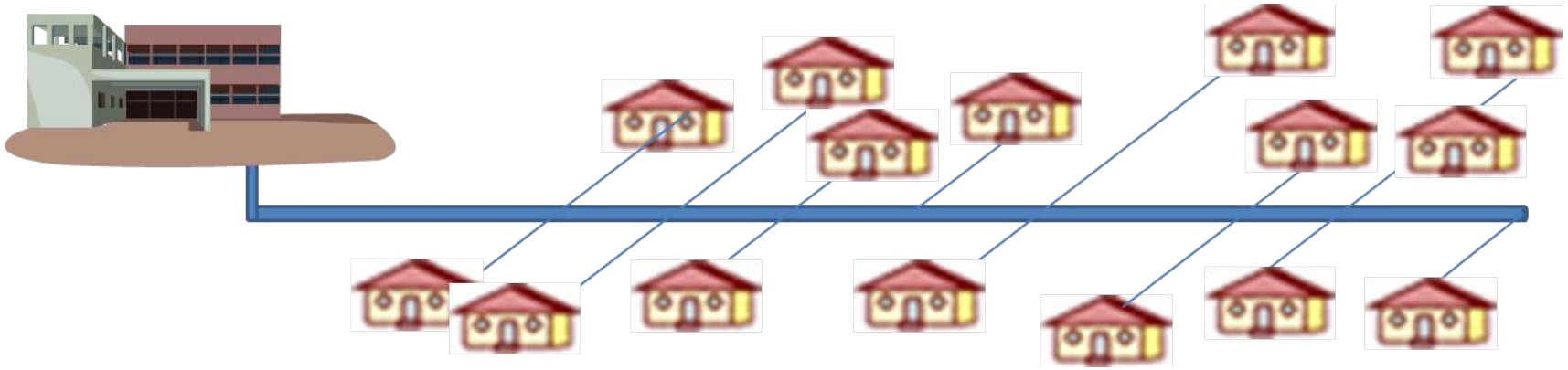
- Includes turbidity, inorganics and organic material.

Process Control

- Controlling the key parameters to ensure proper water quality.
  - Chemical feed rates and application points
  - Mixing time
  - Detention time
- Chemical feed of a disinfectant must be continuous and adequate.

Disinfection: Contact Time

Amount of time (in minutes) necessary for the chlorine to perform its disinfection function before the water is delivered to the first customer.



Chemical Disinfection

- Gas chlorine
- Hypochlorite
- Chlorine Dioxide
- Chloramines
- Ozone

What is the major disadvantage of using gas chlorine?

It requires special training to assure safe handling of the chemical and related equipment.

Surface Water Treatment Rule

Page 1-18 in Workbook

- This rule required all surface waters or **ground waters under the influence of surface waters to provide filtration and/or disinfection** of the source to meet:
  - 3-log removal or inactivation of *Giardia Lamblia* cysts and,
  - 4-log removal or inactivation of enteric viruses.

Disinfection Wrap Up

- Exercise on 1-21
- Key Points on 1-24

(Mod 10) General Maintenance

Unit 1 Learning Objectives

- Define maintenance
- Discuss the roles of maintenance
- Discuss safety practices of maintenance

Definition of Maintenance

- Ensures that all equipment and systems are:
  - Operated at an expected level of reliability
  - Within a specified budget and
  - Within the life cycle of the equipment.

Role of Maintenance

- Some elements of system have a 25 to 30 year life cycle before needing maintenance
- Most elements will need regular service directly after start-up.
- The role of maintenance is to identify and remedy potential problems before they impact plant operation.

5 General Goals of a Maintenance Program

1. Safety and environmental protection (our focus)
2. Fixed asset management
3. Maintenance of design intent
4. Efficiency of operations
5. System reliability

Safety and Environmental Protection

- Water treatment plants have a direct impact on public health.
- Plant operators constantly monitor process parameters to ensure the quality of the water.
- Maintenance must be done to ensure all equipment is functioning properly so all processes can be monitored – helps during operation to ensure water quality while protecting public health.

Follow all safety programs!

- All required safety procedures must be followed at a water system.
  - For example, drinking water system must have specially designed areas for chemical storage which allows containment in case of fire and explosion.

Common Ways to Minimize Hazards

- Use lockout-tagout procedures! Remember, the person performing the maintenance is responsible for following lock out/tag out protocol.
- Before disconnecting power leads, mark the configuration. *Note: by hooking the leads in the reverse, you can change the direction of how a pump will run (a counter clockwise pump will run clockwise).*
- Follow confined space procedures.
- Perform good housekeeping procedures.

Typical Maintenance Procedures

Objectives

- Discuss pump performance issues
- Discuss shaft adjustment
- Discuss mechanical seals
- Discuss lubrication of equipment

Pump Performance Issues

- Maintenance on a pump is important to keep the pump running at its optimum performance level.
- Troubleshooting Example: Pump is running but not discharging, troubleshooting could indicate:
  - The pump has lost its prime
  - Worn impeller
  - Valve on the discharge side is closed

Shaft Seals

Shaft seals will be standard packing or mechanical.

Leaking Gland

Lubrication

- Lubrication protects equipment.

Special Note

- Oil lubricated bearings typically utilize a sight glass or bowl.

  Note: the manufacturer might recommend that you check your electrical amperage before and after greasing bearings. If an increase in electrical amperage is detected, the drag on the bearings has increased due to over-greasing the bearings.

Condition Assessment

- Vibration analysis
- Vibration caused by:
  - Worn bearings, worn housings, loose bolts, and misalignment.
  - Misalignment can occur within a pump or between a motor and a pump which causes excessive vibration.

Vibration Analysis Point

Module 10 Wrap Up

- Exercise on Page 4-8 (Mod 10)
- Key Points on Page 4-9 (Mod 10)

Module 8: Distribution

We will cover:

- Distribution components
- Hydraulics
- Routine Maintenance and Repairs

Distribution Networks

- Purpose
- Components

Pipes

- Transmission Systems
- Service Connections

Storage Facilities

Provide sufficient amount of water to equalize the daily demands on the water supply system.

- Elevated Tanks
- Stand Pipes
- Reservoir or ground level storage tanks
- Pressure Tanks

Valves

- Valves used to stop flow, regulate flow, drain lines or isolate a section of line.
- Valves can be operated manually or by motorized controls that may be operated through a remote.

Meters

Meters measure, display, and record the amount of water that passes through a distribution system component.

Types of Meters

- Displacement Meters
- Velocity Meters
- Compound Meters
- Electric Meters
- Proportional Meters

Backflow Prevention

Purpose of Backflow Prevention

- Prevent potential contaminants from being introduced to the distribution by the **reverse flow of water**

Types of Backflow Prevention Devices

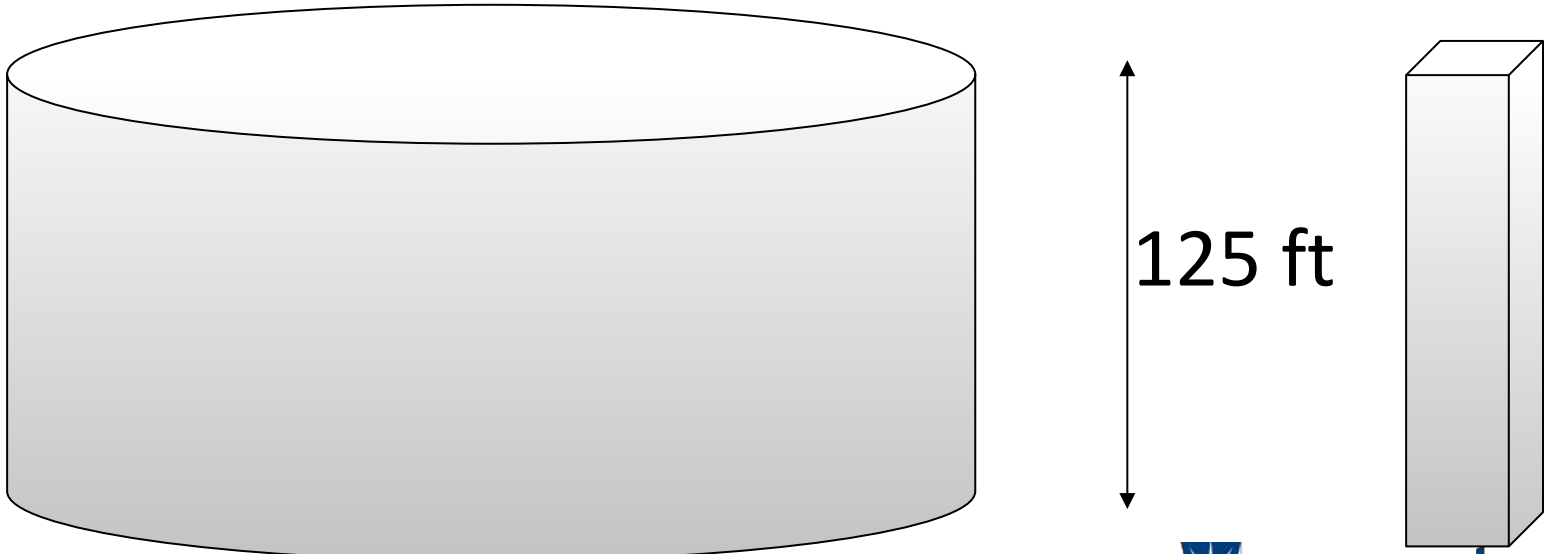
- A physical air gap
- A reduced pressure device
- A double-check valve assembly

Pressure and Head

Pressure - the force per unit of area. Pressure is commonly expressed in units of pounds per square inch (psi).

Pressure, psi = Pressure Head, ft / 2.31, or

Pressure, psi x 2.31 = Pressure Head, ft



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Example 1

What would the pressure head in feet be on a fire hydrant if a pressure gauge on that fire hydrant read 155 psi?

$$ft = \frac{2.31\ ft}{1\ \cancel{psi}} \times \frac{155\ \cancel{psi}}{}$$

$$= (2.31)(155)$$

$$= 358.05\ Feet$$

Example 2

What would the pressure head in psi be on a fire hydrant if a pressure gauge on that fire hydrant read 258 feet?

$$\text{psi} = \frac{1 \text{ psi}}{2.31 \text{ ft}} \times \frac{258 \text{ ft}}{} = \frac{258}{2.31} = 111.7 \text{ psi}$$

Customers and Demands

- **Unaccounted-for Water**— is the difference between the amount of water produced and the amount of water metered for billing purposes.
- Unaccounted for water (the difference between net water produced and total water metered) should not exceed 15%.

Example 1

ABC water treated 96,000,000 gallons of water during December of 2012. Records indicate that ABC billed 88,673,249 gallons for December of 2012. What is their percent of water loss?

96,000,000 gallons - 88,673,249 gallons = 7,326,751 gals

$$\frac{7{,}326{,}751 \text{ gallons}}{96{,}000{,}000 \text{ gallons}} \times 100 = 7.6\% \text{ or } 8\% \text{ Unaccounted}$$

Example 2

The master meter for a system shows a monthly total of 700,000 gallons. 600,000 gallons were used for billing. Another 30,000 gallons was used for flushing. On top of that, 15,000 gallons were used in a fire episode and an estimated 20,000 gallons were lost to a main break that was repaired that same day. What is the total unaccounted for water loss percentage for the month?

600,000 + 30,000 + 15,000 + 20,000 = 665,000 gallons accounted for.

700,000 Master Meter Reading - 665,000 Accounted for Through System = 35,000 Unaccounted for

$$\frac{\text{35,000 Unaccounted For}}{\text{700,000 Master Meter}} = 0.05 \times 100 = \text{5\% Unaccounted For}$$

Customer Types

- Residential
- Commercial
- Industrial
- Other

Routine Maintenance and Repairs

- Pipeline Maintenance and Repairs
- Leak Detection
- Main Break Repair and Replacement
- Cleaning and Lining

Wrap-Up

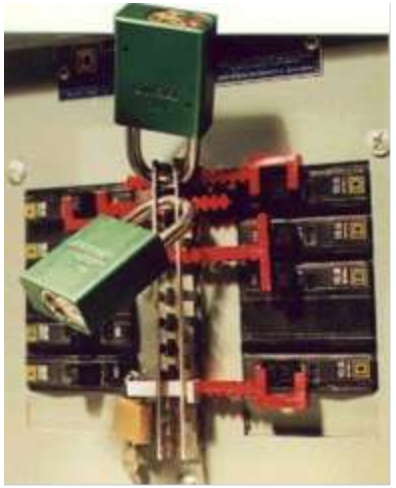
- Distribution Exercise: Page 1-16 (Mod 8)
- Key points: Page 1-17 (Mod 8)

Module 30: Safety/Hazards

- Mechanical Hazards
- Electrical Hazards
- Noise
- Slip, Trip and Fall Hazards
- Excavations
- Confined Space

Lockout/Tagout Program

- Purpose: Ensure that all personnel follow standardized shutdown and startup procedures to prevent accidental equipment start up, energization or release of stored energy
- NOTE: The person performing the maintenance on an electrical device is responsible for the lock out/tagout procedure.



Electrical Hazard Control

Electrical hazards can be controlled by:

- Insulation
- Guarding
- Grounding
- Electrical Protective Devices
- Safe Work Practices
- Deenergizing Electrical Equipment (Lockout/Tagout)
- Tools
- Overhead/Underground Power Lines
- Protective Equipment
- Good Judgment

Noise

Treatment plant operation and maintenance activities expose workers to a variety of intermittent or continuous high noise sources.

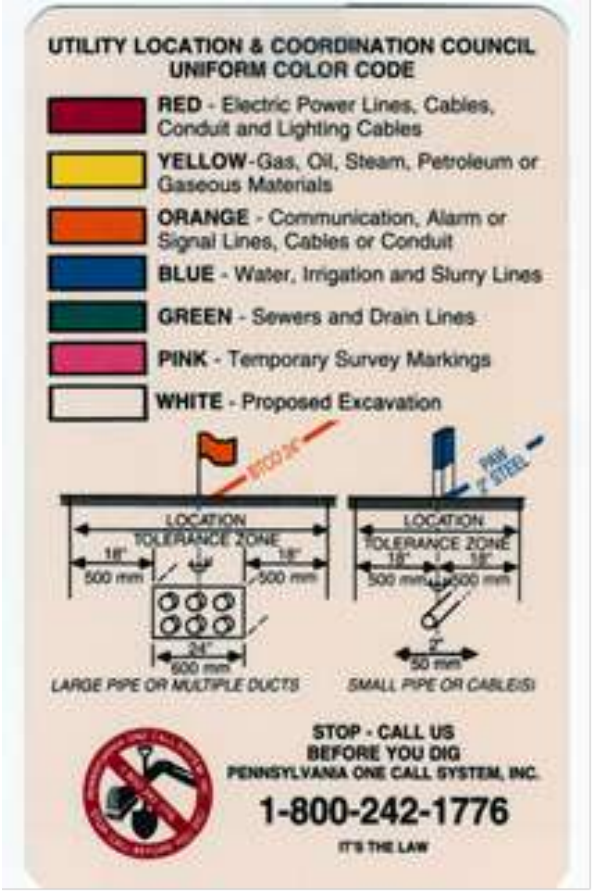
- Monitoring should be performed.
- Hearing conservation program.
- Noise reduction program.
- Calculation on 3-12

Walking/Working Surfaces

- Walking and working surfaces in treatment plants are inherent sources of slip, trip and fall hazards.
- Ladders: must be maintained in good condition.
- Good housekeeping: maintenance of clean dry floors and walkways is important.
- Footwear: good with adequate tread.

Excavation

Remember: Call Before You Dig (PA OneCall)



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Permit-Required Confined Space

One or more of the following hazardous characteristics:

- contains or has the potential to contain a hazardous atmosphere
- contains a material that has the potential to engulf an entrant such as water;
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section such as a hopper or bin;
- contains any other recognized serious safety or health hazard.

Classes of Fire

- **Class A** Includes ordinary combustibles such as wood, paper and textiles.
- **Class B** Includes flammable or combustible liquids such as gasoline, oils, paints and greases.
- **Class C** Are electric fires from wiring and electrical equipment or class A or B fires adjacent to electrical equipment.
- **Class D** Includes combustible metals such as aluminum, magnesium and titanium.

Additional Chemical Storage Tips

Chemical storage requirements are listed on MSDS sheets. In general:

- Store acids and bases separately.
- Store oxidizers and reducers separately.
- No smoking, drinking or eating when working with chemicals.
- Store carbon in a clean, dry place
- Store chlorine in secure areas with leak detection equipment.
- Handle cylinders and containers carefully,
- First aid kits, safety showers and eyewash stations should be available and easy to access.

Safety Wrap Up

- Key points on Page 3-35 (Module 30)

The End

That is the end of the material in the manuals.

However:

- We now have 50 practice questions.
- We will cover all of the questions that we can cover.

1. Uncertified and not appropriately certified operators can only make process control decisions when:

A. They can never make process control decisions
B. Under direction of an appropriately certified operator
C. Using (SOP) developed by a certified operator
D. Both B and C

2. Which of the following most accurately describes a decision which maintains or changes the quality or quantity of water in a system that may affect the public health or the environment:

A. Chemical Feed Modulation
B. Process Control Decision
C. Rate of Flow change
D. None of the above

3. Less dense fluids float on more dense fluids when they do not mix. The mass density of a material varies with temperature. The temperature where water is most dense:

A. 32 Celsius
B. 32 Fahrenheit
C. 39 Celsius
D. 39 Fahrenheit

4. The certification board may revoke, suspend or modify a certificate if it is found an operator has:

A. Been negligent
B. Committed fraud
C. Falsified an application or operating records
D. All of the above

5. Your plant has a 10,000 gallon tank of Aluminum Chloride. The specific gravity of Aluminum Chloride is 1.2. How much (in pounds) does the tank of Aluminum Chloride weigh when the tank is full?

A. 10 pounds
B. 8,333 pounds
C. 12,000 pounds
D. 100,000 pounds

6. This rule required all surface waters or ground waters under the influence of surface waters to provide filtration and/or disinfection of the source to meet 3 log removal or inactivation of *Giardia Lambia cysts* and 4 log removal or inactivation of enteric viruses:

A. Surface Water Treatment Rule
B. Ground Water Rule
C. Filtration Rule
D. Total Coliform Rule

7. Which of the following is an example of an acute violation?

A. A positive sample for total coliforms when E. Coli are present
B. Violation of any maximum contaminant level
C. Failure to comply with a required treatment technique
D. Failure to comply with a variance schedule

8. Which of the following violations pose immediate health effects and therefore require a public notice issued within 24 hours:

A. Tier 1 violation
B. Tier 2 violation
C. Tier 3 violation
D. All of the above

9. To address terrorist threats, systems that serve more than 3,300 people must conduct:

A. Terrorist Susceptibility Analysis
B. Vulnerability Assessment
C. Security Threat Study
D. All of the above

10. What is 80°F in °C?

A. 12
B. 26
C. 48
D. 112

11. Groundwater Under the Direct Influence of Surface Water (GUDI) sources are classified as:

A. Ground Water
B. Drinking Water
C. Surface Water
D. Not potable

12. The hydrologic cycle is:

A. Physical changes that water undergoes continuously
B. Continuous – no starting or ending point
C. The exchange of water between the earth and the atmosphere through evaporation and precipitation
D. All of the above

13. Fluorosilic Acid (60%) has a specific gravity of 1.46. How much would 1 gallon weigh (in pounds)?

A. 5.7
B. 12.2
C. 27.9
D. 59.7

14. The term “aquifer” relates to which one of the following?

A. Surface Water
B. Lake
C. Groundwater
D. Stream

15. Water samples are analyzed for the coliform group of bacteria because these bacteria:

A. Are pathogenic
B. Cause Typhoid
C. Indicate that water is safe
D. Indicate the possible presence of disease-causing organisms

16. Running tap water 30 seconds or more before using the water may reduce:

A. Chlorine level in water
B. pH level in water
C. Lead level in water
D. None of the above

17. Which of the following elements cause hardness in water:

A. Sodium and Potassium
B. Calcium and Magnesium
C. Fluoride and Oxygen
D. Nitrogen and Sulfur

18. Which of the following contaminants is a secondary contaminant?

A. Total Coliforms
B. Iron
C. Copper
D. Lead

19. Which of the following contaminants is chronic?

A. Cadmium
B. Copper
C. Uranium
D. All of the above

20. You plant has a 5,000 gallon bulk tank for 50% NaOH (specific gravity of 1.53). How much (in pounds) does the tank weigh after each fill?

A. 63,800 pounds
B. 35,000 pounds
C. 12,760 pounds
D. 12.76 pounds

21. Which of the following is a Tier 2 MCL violation:

A. Iron
B. Nitrate
C. Manganese
D. Both a and c

22. Detention time is achieved by using:

A. Baffled Tanks
B. Hydraulic Lift
C. Suction Lift
D. Blending

23. Which of the following is an “indicator” test that may be performed to determine if other drinking water pathogens may be present?

A. Fecal Coliform
B. E. Coli
C. Total Coliform
D. None of the above

24. Of the four chemicals listed below, which is the most hazardous?

A. Orthophosphate
B. Chlorine
C. Bicarbonate Soda
D. Fluoride

25. This rule required all surface waters or ground waters under the influence of surface waters to provide filtration and/or disinfection:

A. Surface Water Treatment Rule
B. Stage 2 Disinfectant and Disinfection Byproducts Rule
C. Total Coliform Rule
D. None of the above

26. Following safety procedures and keeping a maintenance program at a treatment facility can:

A. Protect Public Health
B. Ensure the Public Receives a Quality Product
C. Allow containment of chemicals in case of fire and explosion
D. All of the above

27. Who initiates a lock out/tag out procedure?

A. The DEP
B. Your engineering firm
C. Person who performs lock out/tag out
D. OSHA

28. The reversal of the 2 power leads in a 3-phase pump will cause the pump to:

A. rpm increases
B. motor burns up
C. reverse rotation
D. rpm decreases

29. Issues that can cause poor pump performance:

A. Worn Impellers
B. Worn Bearings
C. Both A and B
D. None of the above

30. A manufacture recommends checking electrical amperage of a pump because:

A. If an increase in electrical amperage is detected after greasing the bearings, the drag on the bearings has increased due to over greasing
B. Of operator safety concerns
C. It is important to determine the electrical demand of the pump
D. None of the above

31. Excessive pump vibration can be caused by:

A. Worn bearings and housing
B. Loose bolts
C. Misalignment
D. All of the above

32. Which type of water storage tower is primarily used to maintain system pressure:

A. Stand Pipe
B. Elevated Tank
C. Reservoir
D. None of the above

33. Which type of meter is commonly used as customer service meters:

A. Displacement Meter
B. Velocity Meter
C. Compound Meter
D. Electric Meter

34. The maximum space between fire hydrants in a distribution network:

A. 50 feet
B. 100 feet
C. 250 feet
D. 500 feet

35. What is the pressure in pounds per square inch at the bottom of a standpipe filled to a height of 47 feet?

A. 10.0
B. 15.0
C. 20.3
D. 108.5

36. If the water level in a elevated tank is 100 feet above the ground surface, the pressure at a tap on a line on the ground below the tank will be about:

A. 15.0 pounds per square inch
B. 32.5 pounds per square inch
C. 43.3 pounds per square inch
D. 75 pounds per square inch

37. If a water tank has 55 feet of water in it, what is the pressure at the bottom of the tank?

A. 12 psi
B. 24 psi
C. 75 psi
D. 127 psi

38. The difference between the net water produced and the total water metered:

A. Unaccounted For Water
B. Water Procured
C. Positively Produced
D. Consumptive Demand

42. The majority of sampling inaccuracy is the result of:

A. Confluent growth
B. Laboratory maintenance
C. Poor sampling techniques
D. None of the above

39. The master meter for a system shows a monthly total of 800,000 gallons. Total meter readings for the month are 575,000 gallons. Another 45,000 gallons was used for flushing. On top of that, 35,000 gallons were used in a fire episode and an estimated 30,000 gallons were lost to a main break that was repaired the same day it was found. What is the percent unaccounted water?

A. 1.4 %
B. 14%
C. 28%
D. 85%

40. Prior to excavating a main break, notification must be given to:

A. Identify and locate any underground utilities through a PA One Call (811)
B. To the PA DEP that water contamination will occur
C. To area residence due to breaking noise ordinance
D. To OSHA due to shoring hazards

41. Sodium thiosulfate is used to:

A. Buffer chlorine solutions
B. Neutralize chlorine residuals
C. Detect chlorine leaks
D. Sterilize sample bottles

43. A hearing conservation program includes:

A. Monitoring
B. Conservation
C. Neither a or b
D. Both a and b

44. The purpose of an electrical lock-out device is to:

A. Introduce electrical current to a specific circuit
B. Keep operators out of an electrical control room while maintenance is being performed
C. Lock out an electrical switch box door
D. Positively prevent the operation of an electrical circuit

45. Hypochlorite is:

A. An effective disinfectant
B. Safer to handle than gas chlorine
C. Comes in two forms – sodium and calcium
D. All of the above

46. The act which protects public health, safety and the environment by ensuring that certified operators have the skills, knowledge and abilities to make appropriate process control decisions during the operation of water systems and water distribution systems:

A. Operator Certification Act (Act 11)
B. Drinking Water Rule
C. Safe Water Act
D. Operation Mandate Act

47. Any sample that test positive for total coliforms must:

A. Be analyzed for E. Coli or fecal coliforms
B. Flush the system
C. Analyze for manganese removal efficiency
D. Locate the source

48. A public water system which serves at least 15 service connections used by year round residents or regularly serves at least 25 year round residents is a :

A. Noncommunity Water System
B. Transient Water System
C. Community Water System
D. Public Water Regulator

49. Factor which influence disinfection include:

A. Water chemistry
B. Process Control
C. Byproducts
D. All of the above

50. Your plant treats 36,500,000 gallons during the month of July. The total water measured into various storage tanks is 28,710,000 gallons. What percentage of treated water is unaccounted for?

A. 12.7
B. 21.3
C. 27.2
D. 78.7