Wastewater Operator Certification Training

Module 1:
Introduction to Wastewater Treatment

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The Pennsylvania State Association of Township Supervisors (PSATS)
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Topical Outline

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II. Solids in Water
   A. Types of Solids

III. Effects of Wastewater Discharges
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Unit 1 – Role of the Treatment Plant Operator

Learning Objectives

- List the roles of the Treatment Plant Operator and describe the responsibilities of each.

Planning, Design, and Construction of New Facilities

The Treatment Plant Operator can be an important member of the design team for the construction of new facilities.

- Planning and Design Phase
    - Offer input about the design and how the plant should be operated efficiently.
    - In a plant expansion project, offer important information regarding the limitations of the current facility.
    - Offer input on issues such as maintainability, security, operability, and safety.

- Construction Phase
    - During construction, the Treatment Plant Operator should become familiar with the plant, including equipment and machinery and their operation.

Administration

- Supervision
    - Even small facilities must have a chief operator responsible for overall operation of a plant.
    - Treatment Plant Operator will be responsible for scheduling and supervision activities of other operators, mechanics, and laborers.

- Record Keeping
    - Treatment Plant Operator is ultimately responsible for maintaining accurate records.
    - Accurate records establish history of compliance with NPDES discharge permit and verify plant performance.

- Financial Administration
    - Treatment Plant Operator must identify and manage plant needs, including equipment and personnel.
    - Treatment Plant Operator must be able to create and manage an operating budget.

Wastewater Treatment Plant Operations and Maintenance

- Process Control
    - A certified operator must make all the process control decisions for the system.
        - Available: Must be on-site or be available to be contacted if there is a need to make a process control decision.
        - An available operator must hold the correct certification class and subclass to operate their system (see Unit 4).
        - "Process control" decisions: A process control decision is any action to maintain or change the quality or quantity of water being treated.

- Laboratory Procedures
    - Sample collection
    - Data obtained from sample analysis establishes proof of treatment process performance.
    - Process control depends on reliable laboratory data.

- Mechanical Principles
    - Treatment Plant Operator should have a general knowledge of pumps, hydraulics, electric motors, and circuitry.

Public Relations

Role is to explain the plant purpose and provide operational information to various groups.

- Plant Tours
    - Appearance is important. A clean, well-maintained plant adds credibility to your operation.
    - Annual "open house" provides opportunity for public to learn about the plant and how it operates. Coordinate any plant visits or tours with your security personnel.

- Downstream User Interests
    - Treatment plants protect water for downstream users, so establish role as protector, not polluter.

Safety

- Safety Program Planning
    - Treatment plants should be a safe place to work and visit.
    - Ensure safety by planning programs and training the operators.

What are some typical safety issues in a plant?

Continuing Education

Treatment Plant Operators are required to complete continuing education.

Training Courses and Seminars

Courses and conferences are available through:

- Pa.DEP
- Private Training Providers

Complete catalog is available here: www.earthwise.dep.state.pa.us/edu

Reference Materials

- Pa. DEP Reference
    - Website: www.depweb.state.pa.us/operatorcenter
    - Contains on-line guidance documents that can be downloaded, and other operational aids that the Treatment Plant Operator will find useful.

- EPA Reference
  - Website: http://water.epa.gov/polwaste/wastewater/pubscatalog.cfm
  - At the preceding website, guidance documents on a variety of subjects related to the operation of wastewater treatment plants and collection systems can be found. Some of the guidance must be ordered and some are available on-line.

- Water Environment Federation
  - MOP-11, *Operation of Wastewater Treatment Plants*

- Other References
  - California State University, Sacramento, and EPA, *Operation of Wastewater Treatment Plants*, Volumes I and II
  - California State University, Sacramento, and EPA, *Advanced Wastewater Treatment*

Key Points

Treatment plant operators have many responsibilities ranging from:

- Administration
- Planning and Design
- Operations and Maintenance
- Public relations
- Supervision
- Laboratory procedures
- Continuing Education

Unit 1 Exercise

1. **True or False:** Treatment plant operators are required to complete continuing education.

2. A process control decision is any action to maintain or change the ______________ or _______________ of water being treated.

3. Which one of the following is a treatment plant operator NOT responsible for:

   a. Plant tours
   b. Process control decisions
   c. Upgrading the electrical service panel
   d. Collecting samples

Unit 2 – Characteristics of Wastewater

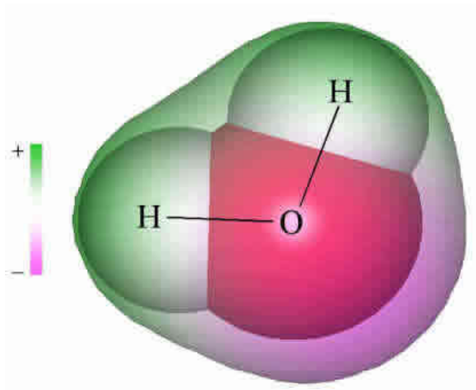
Learning Objectives

- Describe the typical composition of raw wastewater.
- Explain the effects of wastewater discharges on the receiving stream.
- Identify how treatment plant discharge impacts natural cycles.

Wastewater contains many substances that are considered impurities. Impurities are any substances that are not found in "pure" water.

Pure Water

Pure water is 2 parts hydrogen, 1 part oxygen. In nature, water contains many dissolved impurities. In fact, water is referred to as "the universal solvent" due to its ability to dissolve many substances.



- Even distilled water and rainfall are not "completely" pure because they usually contain very low levels of dissolved substances such as ammonia, which are considered impurities.

- There are dissolved substances found in surface and ground water.
  - As rain falls, nitrogen and other gasses are absorbed.
  - Water, as it travels through the ground, can dissolve substances from the earth such as sodium, calcium, iron, phosphorus, magnesium, and sulfate.

Contaminants Typically Found in Untreated Wastewater

Fresh domestic untreated or raw wastewater has a musty odor, a pH range of 6.5 to 8.0 and is grayish-brown in color.

A summary of the types of contaminants typically found in untreated wastewater and the importance of each is presented in Table 2.1. These contaminants can be broadly lumped into four basic classes:

- Organic contaminants;
- Inorganic contaminants;
- Pathogens; and
- Other contaminants.

Typical concentrations of many of these contaminants are listed in Table 2.2.

Table 2.1 Typical contaminants found in untreated wastewater.[1]

Contaminants	Reason for importance
Suspended solids	Suspended solids can lead to the development of sludge deposits and anaerobic conditions when untreated wastewater is discharged in the aquatic environment.
Biodegradable organics	Composed principally of proteins, carbohydrates, and fats, biodegradable organics are measured most common in terms of BOD (biochemical oxygen demand) and COD (chemical oxygen demand). If discharged untreated to the environment, their biological stabilization can lead to the depletion of natural oxygen resources and to the development of septic conditions.
Pathogens	Communicable diseases can be transmitted by the pathogenic organisms in wastewater.
Nutrients	Both nitrogen and phosphorus, along with carbon, are essential nutrients for growth. When discharged to the aquatic environment, these nutrients can lead to the growth of undesirable aquatic life. When discharged in excessive amounts on land, they can also lead to the pollution of groundwater.
Priority pollutants	Organic and inorganic compounds selected on the basis of their unknown or suspected carcinogenicity, mutagenicity, or high acute toxicity. The presence of these compounds in wastewater must be minimized for public health reasons and to protect the biological treatment processes.
Refractory organics	These organics tend to resist conventional methods of wastewater treatment. Typical examples include surfactants, phenols, and agricultural pesticides. Some of these may be toxic to the biological treatment processes.
Heavy metals	Heavy metals are usually added to wastewater from commercial and industrial activities and may have to be removed if the wastewater is discharged to a stream used as a potable water source. The presence of heavy metals may also impact the recycling of biosolids (stabilized waste sludge) on farmland.
Dissolved inorganics	Inorganic constituents such as calcium, sodium, and sulfate are added to the original domestic water supply as a result of water use and may have to be removed if the wastewater is discharged to a stream used as a potable water source.

Table 2.2 Typical composition of untreated domestic wastewater.[2]

Contaminants	Unit	Concentration		
		Weak	Medium	Strong
Solids, total (TS)	mg/L	350	720	1200
Dissolved, total (TDS)	mg/L	250	500	850
Fixed	mg/L	145	300	525
Volatile	mg/L	105	200	325
Suspended solids (SS)	mg/L	100	220	350
Fixed	mg/L	20	55	75
Volatile	mg/L	80	165	275
Settleable solids	ml/L	5	10	20
Biochemical oxygen demand, mg/L:				
5-day, 20ºC (BOD_5, 20ºC)	mg/L	110	220	400
Total organic carbon (TOC)	mg/L	80	160	290
Chemical oxygen demand (COD)	mg/L	250	500	1000
Nitrogen (total as N)	mg/L	20	40	85
Organic	mg/L	8	15	35
Free ammonia	mg/L	12	25	50
Nitrites	mg/L	0	0	0
Nitrates	mg/L	0	0	0
Phosphorus (total as P)	mg/L	4	8	15
Organic	mg/L	1	3	5
Inorganic	mg/L	3	5	10
Chlorides	mg/L	30	50	100
Sulfate	mg/L	20	30	50
Alkalinity (as $CaCO_3$)	mg/L	50	100	200
Grease	mg/L	50	100	150
Total coliform	no/100 mL	10^6-10^7	10^7-10^8	10^7-10^9
Volatile organic compounds (VOCs)	µg/L	<100	100-400	>400

- Contaminant concentrations are often used to describe the “strength” of the wastewater. The strength, or concentration, will vary depending on the volume of diluting water and the types of users discharging to the plant. For example, a sewer system containing significant amounts of infiltration/inflow (clean water entering the sewer system from rain storms, groundwater etc…) will tend to have contaminants of relatively low concentrations, whereas a system with high-strength industrial dischargers will contain some contaminants with higher concentrations. While the concentrations shown in Table 2.2 are typical of domestic strength wastewater, your system may be different depending on the types of users present. It is your job as the Plant Operator to characterize the wastewater entering your plant.

Organic Contaminants

Organic contaminants are derived from animals and plants, or may be manufactured chemical compounds. However, all organics contain carbon. Organic contaminants can be biodegradable, which means that the contaminants can be consumed by bacteria and other microorganisms. In the process of being consumed, these organics will exert an oxygen demand which can be measured as the Biochemical Oxygen Demand (BOD) of the wastewater. Some organic contaminants (refractory organics) are resistant to biodegradation.

➢ In a typical domestic wastewater treatment plant, the BOD of the influent raw wastewater ranges around 200 to 250 mg/L (Table 2.2 has the full range). Sudden or drastic increases in BOD loadings at a wastewater plant are examples of organic shock loadings and may lead to treatment plant upsets. When shock loads are suspected, plant representatives should begin looking for potential sources of elevated organic loads.

Higher soluble BOD levels are result of organic sources in the influent, such as:

- Domestic contributors
  - Household waste
- Industrial contributors
  - Food processing facilities including packing/processing of fruit, vegetable, meat, poultry, dairy.
  - Paper manufacturers

Some organic solvents were historically found in wastewater, such as trichloroethylene (TCE) from dry cleaning facilities. TCE has not been used in dry cleaning since the 1950s.

What are some examples of organic impurities from industrial contributors?

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Inorganic Contaminants

Inorganic contaminants are not biodegradable, but may be nutrients necessary for microorganisms to live. These are typically chemical compounds (priority pollutants) or metals that are either present in the wastewater as suspended solids or as dissolved inorganics.

- Examples of inorganic contaminants include:
    - The sodium chloride byproduct from the water softening process adds to the total dissolved solid content in water.
    - Nutrients such as phosphorus and ammonia-nitrogen. Both of these nutrients are typically found in domestic sewage, internal recycle flows (belt press filtrate or anaerobic digester supernate), and trucked in wastes.
    - The filter backwash from drinking water facilities is often high in suspended solids and low in organic loading.
    - Street cleaning or sidewalk washing introduces soil, sand, or grit.
    - Copper (a heavy metal) dissolved from household plumbing.
    - Other toxic metals from industrial processes.

Pathogens

Pathogens are disease-causing organisms including bacteria and viruses that can be deposited in the wastewater through human or animal wastes, or from improperly handled hospitals wastes. Proper hygiene is extremely important when working around wastewater.

Because the potential disease is so great, it is important that wastewater be treated and disinfected to inactivate the pathogens prior to discharge to the receiving stream. It is particularly important if the receiving stream is used for recreational purposes (e.g., boating, swimming and fishing) or as a drinking water source.

Examples of diseases caused by pathogens that may be found in wastewater include:

- Typhoid
- Cholera
- Dysentery
- Polio
- Hepatitis

Other Impurities

- Thermal Wastes
    - Industrial waste discharges can cause a sudden increase in influent temperature and flow. A typical source of thermal waste is non-contact cooling water (heated water where the temperature exceeds stream temperature). Depending on the use of the stream, limits on the temperature of the wastewater may be established to prevent elevating the temperature of the stream and impacting use.

A stream used for trout stocking is one example of a thermal sensitive stream where the stream temperature needs to be regulated. Can anyone think of any other reasons to regulate the temperature of discharges to the receiving stream?

- Radioactive Wastes
    - Could come from nuclear power plants, hospitals, or laboratories. Generally, it is good practice not to allow the discharge of radioactive wastes into a sewer system. EPA lists this as a suggested prohibited waste in their general pretreatment program guidelines. More information regarding the USEPA National Pretreatment Program may be found at http://water.epa.gov/polwaste/npdes/pretreatment/ .

Types of Solids

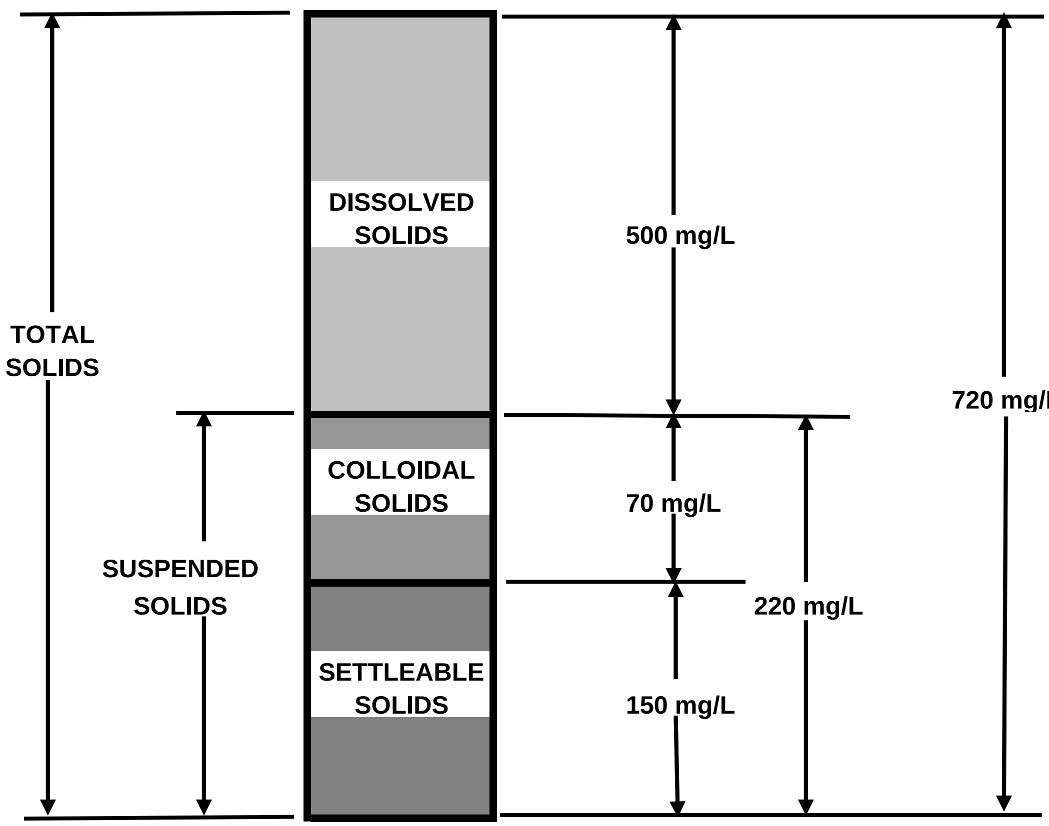

Figure 2.1 Typical solids concentrations in raw wastewater.

Total Solids

- Total dissolved and suspended organic and inorganic residue left after evaporation, expressed in mg/L.
- Total solids include both dissolved and suspended materials.
- Suspended solids include both **nonsettleable** (shown in Figure 2.1 above as **colloidal solids**) and settleable materials.
- Total solids concentration in Figure 2.1 is 720mg/L.

Dissolved Solids

- Solids which will pass through a standard glass fiber filter.
- Dissolved solids weight is the difference in weight between total solids and suspended solids.
- When a sample is filtered through fine mesh filter (example - 0.45 micron membrane filter), the suspended solids are captured on the filter pad and the dissolved solids will remain in the water passing through the filter.
- To determine the weight of dissolved solids, sample the water that passed through the filter. Evaporate the sample and weigh residue to determine weight of dissolved solids.
- Dissolved solids concentration in Figure 2.1 is 500mg/L.

Suspended Solids

- Suspended solids are the solids that are captured on the filter pad, or the difference between the total and dissolved solids content of the sample.
- Includes solids which will settle or float in a clarifier and the lighter nonsettleable (colloidal) solids.
- The type of suspended solids is determined by size, shape, and weight.
- Suspended solids concentration in Figure 2.1 is 220 mg/L.

Settleable Solids

- A portion of the Suspended Solids
- Large size particles settle more rapidly.
- Settleable solids are estimated before designing settling basins, sludge pumps and sludge handling facilities.
- Measuring settleable solids enables calculation of basin efficiency of removal of solids.
- Imhoff cone measures solids in ml/L.

Nonsettleable (Colloidal) Solids

- A portion of Suspended Solids

- The colloidal solids will not settle but will remain in suspension after the settleable solids have precipitated out. The removal of colloidal solids usually requires the addition of a chemical flocculating agent or filtration.

- Calculated by subtracting the weight of settleable solids from the weight of suspended solids.

- Nonsettleable solids concentration in Figure 2.1 is 70 mg/L

Floatable Solids

- Floatable solids are typically nonsettleable solids that make their way to the surface of a tank or stream.

- There is no standard for measuring and evaluating floatable solids.

- Typically made up of fat or grease particle and make up the scum. Scum is most easily removed by surface skimming equipment on the primary or secondary clarifiers. This equipment will be discussed further in the section on treatment processes.

- They are undesirable and unsightly, and can cause odors.

EFFECTS OF WASTEWATER DISCHARGES

A **discharge** is the release of treated or untreated wastewater into a receiving stream. A discharge may occur from a treatment plant or from an overflow in the collection system.

Untreated wastewater discharge can create several undesirable conditions. These include:

- Oxygen depletion and odor production in the stream.
- Negative effects on human health.
- Sludge and scum accumulations.

Oxygen Depletion and Odor Production

Oxygen Levels for Aquatic Life

- The dissolved oxygen (DO) content of a stream will depend on the temperature and the flow characteristics.
    - Cold water can retain higher dissolved oxygen content than warm water. As water temperatures increase, dissolved oxygen levels will decrease.
    - Turbulent flow will add more dissolved oxygen to the stream than non-turbulent flow.
- The desired oxygen level to sustain living creatures (including aquatic life) is 5 mg/L.

Effects of Organic Waste Discharge

Aerobic bacteria are bacteria that **use dissolved oxygen** to live and reproduce.

Anaerobic bacteria are bacteria that live and reproduce in an environment containing **no dissolved oxygen**. The bacteria obtain oxygen by breaking down chemical compounds, which contain oxygen (examples- sulfate and nitrate).

- Organic waste is discharged to the receiving stream; bacteria numbers increase (as does oxygen use).
    - When oxygen is used faster than it is replenished, aquatic life can die from insufficient oxygen.
- Anaerobic bacteria remove oxygen from sulfate; the sulfate is reduced to sulfide, which can combine with hydrogen in water to produce hydrogen sulfide (rotten egg odor).

- The following diagram illustrates oxygen utilization and the impact on aquatic life.

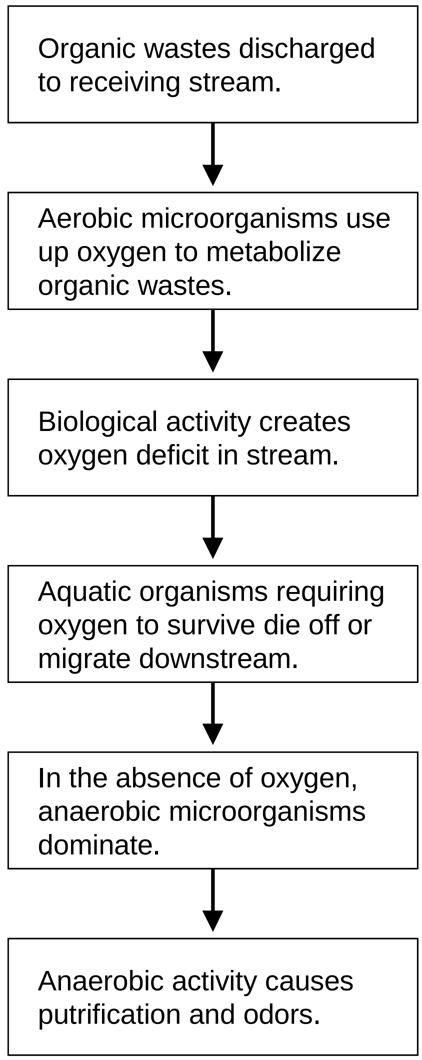

Figure 2.2 Oxygen utilization by aerobic microorganisms and odor production by anaerobic microorganisms.

Treatment Objective—Stabilization

The objective is to prevent oxygen-demanding material from entering water.

Stabilization is the process of converting a waste to a form that resists change. Stabilized material usually does not give off bad odors.

- Organic material is stabilized when bacteria convert the material to new growth, carbon dioxide, and water.

Human Health

Disease-Causing Bacteria

- Pathogenic organisms
    - Introduced into water by human disease carriers.
    - Generally these organisms do not thrive in wastewater or receiving waters and many die off in normal treatment process.

Communicable means easily transmitted.

What are some communicable diseases that could be transmitted via untreated wastewater?

Treatment Objective—Disinfection

- Can be accomplished by addition of a disinfectant such as chlorine to the water or through ultraviolet radiation.
- Works best if wastewater is treated to remove solids and other contaminants prior to disinfection.

Scum and Sludge Accumulation

Scum and sludge can accumulate in the receiving water banks or beds or can float on the water surface.

Effects of Accumulations of Scum and Sludge

- Oxygen depletion occurs from metabolism of the organic matter contained in the sludge.
- Odors occur from continued biological activity after oxygen is depleted.

Treatment Objective

- Remove sludge and scum before it can reach receiving waters.

Other Effects

- Clarity and color determine if water is desirable for recreation.
- Changes in pH (acidic or alkaline water) can disrupt aquatic life.
- Toxic discharges (heavy metals such as lead, mercury, and chromium) or cyanide also impact aquatic life and domestic use.
- Bad taste and odor are undesirable for drinking water sources.
- Nutrients
  - Support living plants and organisms (carbon, hydrogen, oxygen, etc.).
  - Encourage algae and plant growth, which interferes with domestic, industrial, and recreational uses.
  - Can lead to oxygen depletion in the receiving stream.
- Eutrophication-An extreme result of excessive nutrient availability
  - A condition in a lake or pond characterized by an abundance of nutrients and organics.
  - Characterized by overgrowth of aquatic weeds and algae.
  - A natural aging process that can be accelerated through the discharge of untreated/under treated wastewater.
  - Often leads to oxygen deficits, compounded by large day-night swings in available dissolved oxygen brought on by photosynthesis and respiration.
  - Can be detrimental to aquatic life.

Photosynthesis is the process whereby green plants containing chlorophyll convert carbon dioxide and other nutrients to new growth and oxygen, in the presence of sunlight.

Respiration is the process whereby oxygen is used as an energy source by an organism during metabolism of food (organic matter).

Impact of Discharge on Natural Cycles

The impact on cycles in the receiving water varies based on the following factors.

- Degree and type of treatment
    - Wastewater receiving only Primary Treatment will have a greater negative impact on the receiving stream than wastewater receiving Primary and Secondary Treatment.
- Discharge flow rate
    - A greater volume of flow will carry a greater mass of pollutants to the receiving stream.
- Discharge characteristics
    - The more pollutants that are removed during treatment, the lesser the impact on the receiving stream.
- Dilution in receiving stream
    - Relates to discharge flow rate—generally, the greater the dilution with the receiving stream, the lesser the impact of the discharge.
- Ambient quality of receiving stream
    - Characteristics of the stream before discharge is introduced will impact on the amount of additional pollutants the stream can receive and still regenerate itself.
- Amount of mixing of discharge with receiving stream
    - Mixing affects dilution of the discharge. Generally, better mixing of the discharge with the receiving stream will prevent localized impacts from a concentrated discharge.
- Use of receiving stream
    - Some uses (e.g., recreation or drinking water source) will require that the wastewater meet stricter discharge limits, requiring a higher degree of treatment.

Nutrient Cycles

- A Nutrient Cycle is a natural cycle that occurs continuously in both receiving stream and the wastewater treatment plant.

- Important nutrients include carbon, hydrogen, oxygen, sulfur, nitrogen, and phosphorous. Each having their own cycle, yet impact one another.

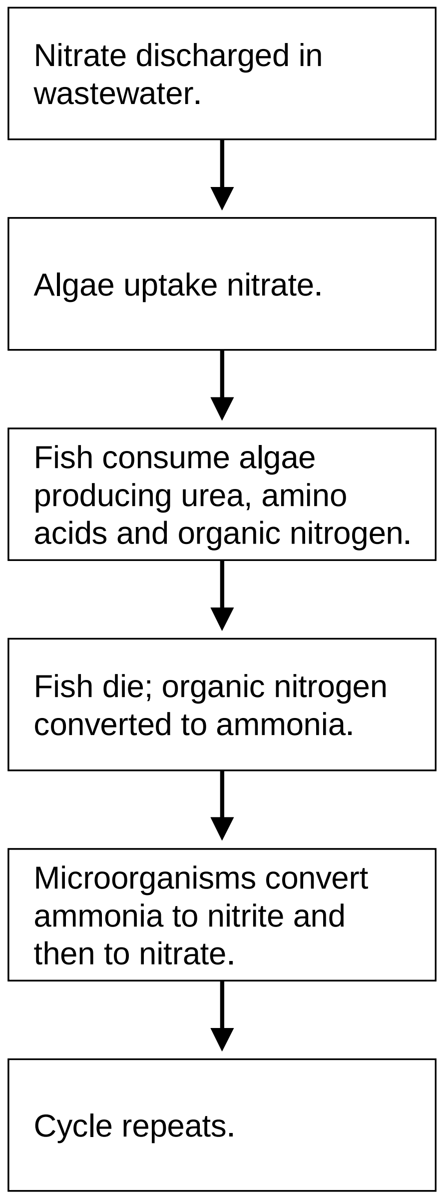

Figure 2.3 Simplified nitrogen cycle

Key Points

- Wastewater typically contains organic and inorganic contaminants, pathogens and other contaminants.
- Wastewater treatment plants typically measure total solids, settleable solids and suspended solids.
- It is desirable to remove most of the solids from wastewater before discharge due to the impact (oxygen depletion) on receiving streams.
- The filter backwash from drinking water facilities is often high in suspended solids and low in organic loading.
- Suspended solids include both nonsettleable (shown in Figure 2.1 as colloidal solids) and settleable materials.
- It is desirable to reduce the nutrient content of wastewater before discharge due to the impact (excessive algae growth and eventual oxygen depletion) on the receiving stream.
- It is desirable to reduce the pathogen content in wastewater due to the effect on human health.

References

[1] *Wastewater Engineering*, 3rd Edition, Metcalf & Eddy, (1991).

[2] *Wastewater Engineering*.

Unit 2 Exercise

1. Contaminants found in untreated wastewater may include: (Circle all that apply):
    a. Pathogens
    b. Ozone
    c. Organic contaminants
    d. Inorganic contaminants

2. A type of contaminant that always contains carbon and is derived from animals, plants or may be a manufactured chemical compound is an:
    a. Inorganic contaminant
    b. Salt contaminant
    c. Organic contaminant
    d. Pathogen

3. Organic contaminants exert an oxygen demand, which is measured as ______________________.

4. Typical influent (untreated) BOD to a wastewater plant is approximately:
    a. 20 to 30 mg/L
    b. 100 to 125 mg/L
    c. 200 to 250 mg/L
    d. 500 to 600 mg/L

5. Typical influent (untreated) total nitrogen concentration is approximately:
    a. 0 to 5 mg/L
    b. 30 to 50 mg/L
    c. 100 to 125 mg/L
    d. 300 to 350 mg/L

6. True or False: Total solids consist of dissolved solids and suspended solids.

7. Influent wastewater flow and temperature can increase suddenly due to which of the following (circle the correct answer)
    a. Infiltration
    b. Increased return activated sludge
    c. Industrial waste discharges
    d. Increased solids removal

8. Untreated wastewater discharge can create which of the following?
    a. High chlorine levels in the receiving stream
    b. Oxygen depletion in the receiving stream
    c. Sludge and scum accumulations
    d. Low odor production in the stream

9. Eutrophication can be defined as:
   a. Lack of nutrients in a receiving stream due to chemical discharges
   b. Excessive nutrient availability that results in overgrowth of aquatic plants and algae
   c. Excessive growth of fish
   d. Pleasing taste and odor in drinking water

10. ______________________ is the process of converting a waste to a form that resists change.

11. True or False: An increase in wastewater temperature results in a decreased ability to retain dissolved oxygen.

12. Important nutrients have natural "Nutrient Cycles" in the receiving stream and within the wastewater treatment plant. Name at least 3 of these nutrients:

    ____

    ____

    ____

    ____

    ____

    ____

Unit 3 – Basic Wastewater Treatment Processes

Learning Objectives

- Describe how wastewater is collected and transported to a treatment plant.
- Indicate the function of each treatment process.
- Describe two methods of effluent disposal.

Three major components of a Wastewater System:

1. Collection/Conveyance

2. Treatment

3. Disposal

General Information

Collection and Conveyance

Factors that affect the operation of the collection system and ultimately impact treatment plant performance include:

- *Seasonal flow* and *loading variations* by industrial users.
  - Short-term overloads
  - Changes in process loadings

- Knowledge of *location*, *amount*, and *types* of wastes from major water-using industries enables operator to locate sources of problems in the influent.

- Long *travel times* can result in septicity and hydrogen sulfide generation.
  - Rotten-egg odor
  - Concrete degeneration

Septicity is a condition brought on by the action of anaerobic bacteria in a wastewater devoid of dissolved oxygen. Septic wastewater has a characteristic black color.

Influent is wastewater or other liquid that is raw (untreated) or partially treated that flows into a treatment process or treatment plant.

Types of Collection Systems

- Sanitary Sewer
  - Collects commercial and household wastes (sometimes industrial).
  - A sanitary sewer does not include any storm water.

- Storm Sewer
  - Collects runoff from streets, land, and roofs.
  - Historically discharge has been discharged to the stream without treatment.

- Combined Sewer
  - Collects sanitary and storm water.
  - During storms, high flows can create short-term overloading conditions at treatment plant, impacting treatment efficiencies.
  - Separating combined sewers is costly.

Why should the operator be familiar with the wastewater collection and conveyance network?[1]

Wastewater Conveyance Systems

- Gravity Sewer
    - Used when slope is sufficient to produce velocity of 2 feet/second.

- Pumping Stations and Force Mains
    - Lift wastewater to higher point so it will again flow with gravity.
    - Pumped under pressure directly to plant.

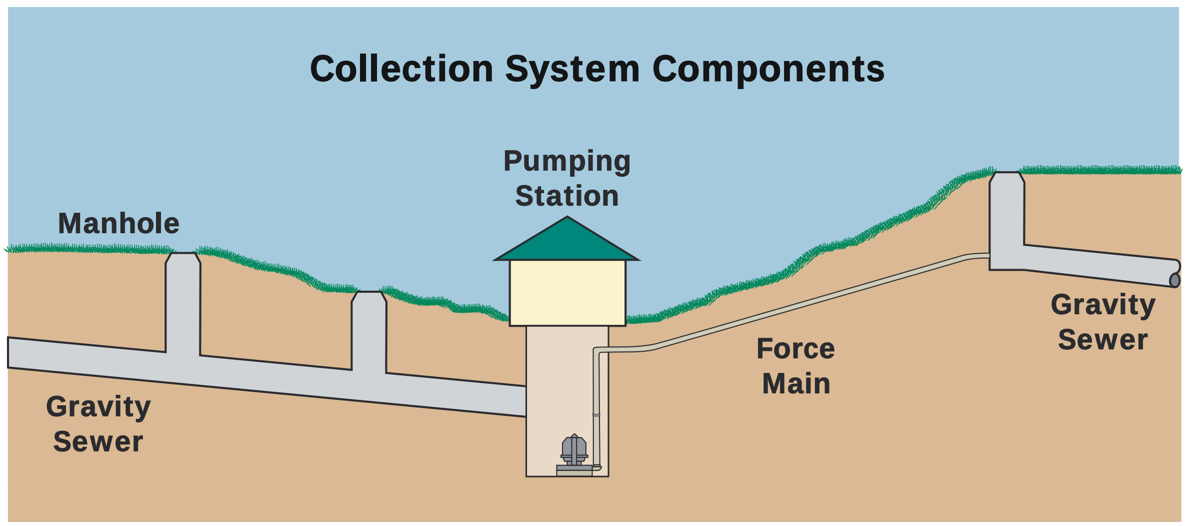

Figure 3.1 Typical wastewater collection and conveyance system

Three major components of a Wastewater System:

1. Collection/Conveyance
2. Treatment
3. Disposal

After the wastewater has been collected and transported to the plant, it is time for the treatment to begin.

Table 3.1 Wastewater treatment process

TREATMENT PROCESS	PROCESS DESCRIPTION
Preliminary Treatment	
Screening	Removes rags, sticks, and other debris; protects pumping equipment
Degritting	Removes settleable inorganic grit
Pre-Aeration	Adds oxygen to the wastewater to reduce odors
Flow Metering and Sampling	Measures and records flows; sample wastewater for analyses of components
Primary Treatment	
Sedimentation and Flotation	Removes settleable organic and inorganic particles and floating debris such as fats, oils, and greases
Secondary Treatment	
Biological Treatment	Removes dissolved and remaining colloidal (also known as nonsettleable) organic matter; can convert ammonia-nitrogen to nitrate-nitrogen
Sedimentation	Separates biomass and chemical precipitates from treated wastewater
Tertiary (Advanced) Treatment	
Chemical Phosphorus Removal	Adds chemical to form precipitate with phosphorus for removal in the secondary clarifiers
Biological Nutrient Removal	Removes nitrogen and phosphorus using specialized microorganisms
Multimedia Filtration	Removes additional suspended solids (beyond that obtained by simple settling) using gravity or pressure filters
Disinfection	
Disinfection	Kills pathogenic organisms
Solids Treatment	
Digestion	Stabilizes remaining organic matter; reduces pathogen levels; results in overall net reduction in solids
Disposal	Moves stabilized solids from plant to farmland for recycling or to landfill

Preliminary Treatment

Preliminary Treatment includes several processes.

Screening and Comminution (Shredding)

Purpose

- Screening removes roots, rags, cans, and other large debris.
- A comminuter grinds up rags and debris but does not physically remove debris from the wastewater.

Process Description

- Debris is captured on screens consisting of parallel bars placed at an angle.
- Screenings collected on bars must be raked off (manually or mechanically).
- Screenings are typically disposed of in sanitary landfills.
- Debris ground-up by a comminuter typically becomes part of the waste sludge.

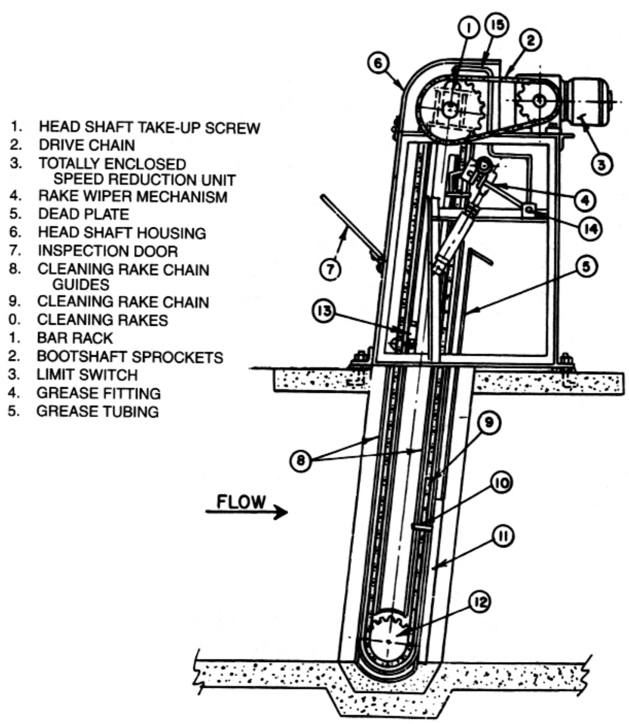

Figure 3.2 Screening

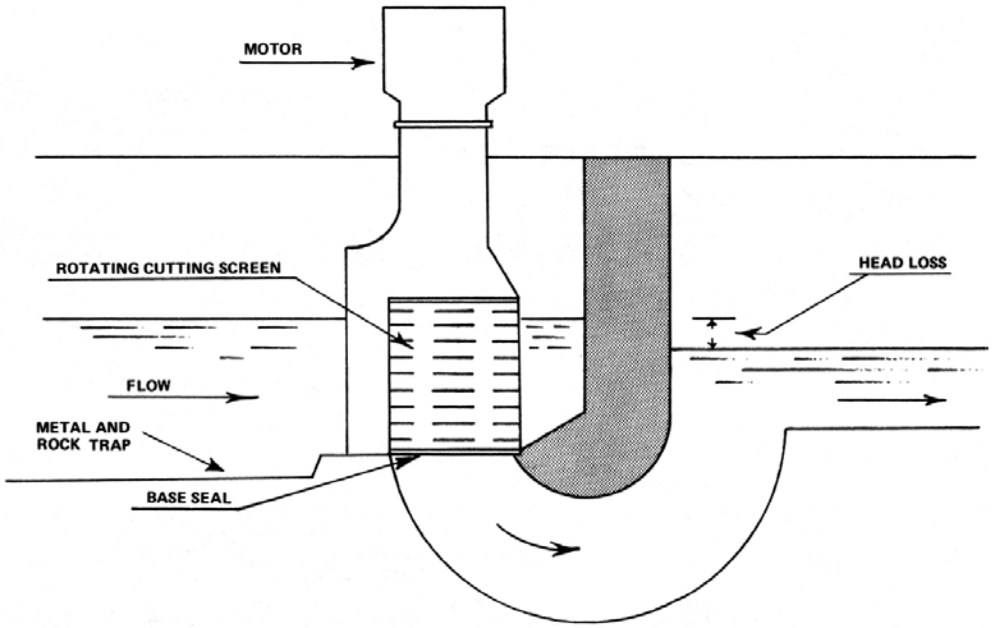

Figure 3.3 Comminuter

Grit Removal

Grit is heavy inorganic material in wastewater, such as sand, coffee grounds, eggshells, gravel, and cinders. Grit is abrasive on pumps and other equipment, and it is best if removed early in treatment.

Purpose

- Grit is removed from wastewater to minimize abrasion to pumps and equipment, and to prevent the accumulation of grit in treatment units, particularly sludge treatment and storage units, which would reduce the capacity of those units.

Process Description

- Velocity of wastewater flow is controlled so that material (coffee grounds, sand, eggshells, etc.) will settle out.

- Grit is typically disposed of in sanitary landfills; however, other options include incineration and land application.

- Grit Channels:
  - Hand-cleaned or mechanically cleaned horizontal channel. Flow of wastewater is reduced to around 1 foot per second to allow grit to settle.

- Cleaning the grit form the channel is important to maintain grit removal efficiency. Cleaning the channel helps to keep the flow velocity of wastewater low. As more grit builds up, the velocity of wastewater increases and removal efficiency decreases.

- Other grit removal technologies:
  - Aerated grit chambers
  - Centrifugal grit separators

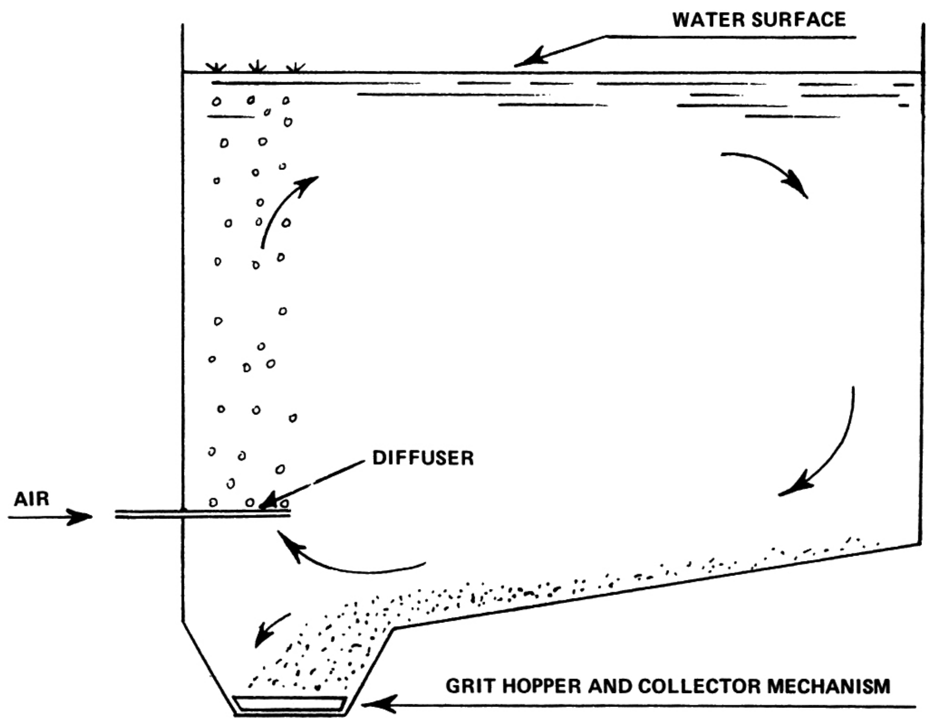

Figure 3.4 Aerated grit chamber

Pre-aeration

Purpose

- Adds oxygen to "freshen" wastewater.

Process Description

- Air is added into pre-aeration chambers to provide oxygen to the wastewater, thereby maintaining aerobic conditions and preventing septicity.

Flow Metering

Purpose

- Flow rates must be known to calculate mass loading rates for process control, to determine chlorination rates and aeration rates, as well as other chemical addition processes in the plant.

Process Description

Open Channel Flow – Flow in any channel where liquid flows with a free surface. Examples are partially filled pipes, streams and rivers.

™ Open channel flow measurement—wastewater flows through a flow control device that allows the flow rate to be determined by the depth of flow in the channel. In wastewater plants, there are many options for measuring open channel flow including:

- Parshall Flume
- Weir
- Kennison Nozzle

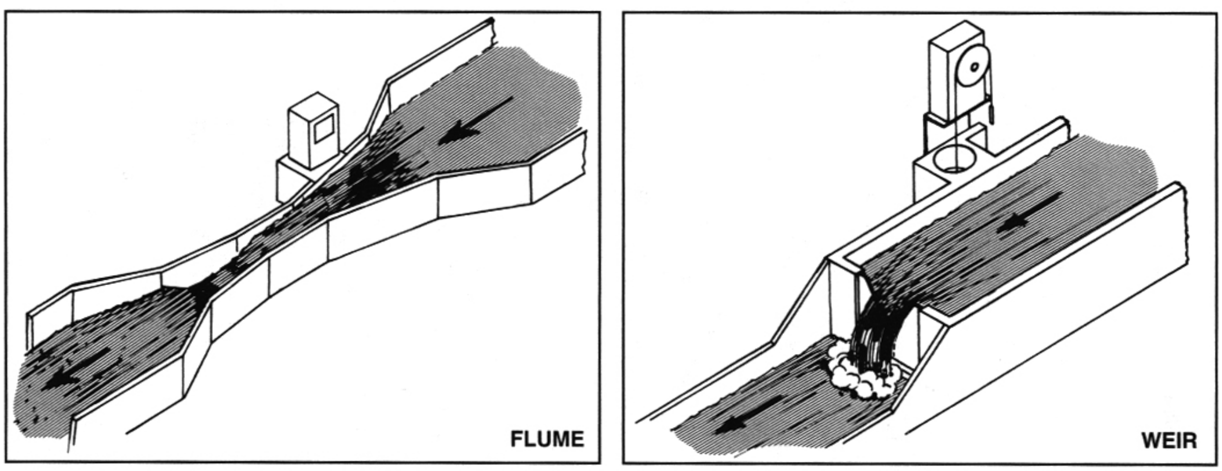

Figure 3.5 Flow metering[3]

- Depth of flow is measured by a float or ultrasonic level sensing device; flow rate is calculated based on the depth of flow and the geometry of the channel.

Why is the parshall flume widely used for measuring wastewater flow? Why is the weir not used very frequently to measure influent?[4]

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Closed Conduit (Pipe Flow)

- Closed conduit flow measurement—flow in a force main can be measured by a device placed in the piping or strapped to the outside of the pipe. Flow is calculated based on the *velocity* (speed) of flow in the pipe and the size of the pipe. (Pipe must be flowing full.)
  - Mag Meter is placed in the force main so that the wastewater flows through the unit. Flow velocity is measured based on the amount of induced current produced by the flow passing through a magnetic field set up by the meter.
  - Doppler or Transit-time meter is strapped to the outside of the force main. It sends a sonic pulse through the pipe wall into the flow stream and measures the time it takes for the signal to bounce back.

Primary Treatment (Sedimentation)

Primary Treatment is a physical (non-biological) treatment process that takes place in a tank and allows substances to settle or float, and be separated from the water being treated.

Purpose

- Remove settleable and floating solids prior to secondary treatment.

Process Description

- Flow controlled (reduced) so that settleable solids fall to bottom of tank and lighter materials rise to water surface.
- Primary Sedimentation tanks are also called primary clarifiers.
- The layer of solids that settle out is sometimes referred to as the **sludge blanket.**
- Solids that settle out in the primary clarifier must be removed (wasted) periodically to digestion.
- Floating material is removed by a surface skimmer and conveyed to the digestion process.
- If sludge removed is watery and not substantial, the removal rate may be too high.

Sludge is settleable solids separated from liquids during processing, or deposits of foreign materials on the bottoms of streams or other bodies of water.[5]

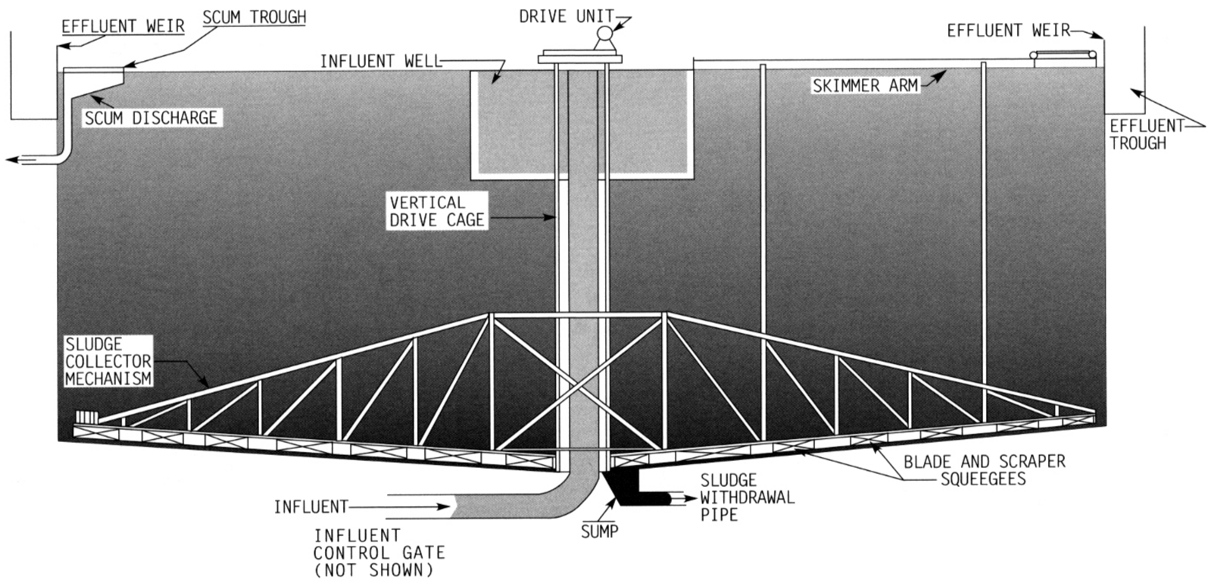

Figure 3.6 Primary clarifier.[6]

Secondary Treatment (Biological)

Secondary Treatment is a biological treatment process used to remove dissolved and suspended organic materials from the water being treated.

Purpose

- Eliminate the dissolved and nonsettleable (also known as **colloidal**) organic material remaining in the waste after primary treatment.

Impacts

- A biological treatment process is a living process and is susceptible to many outside influences, including:
  - Temperature effects which could result from industrial sources, wet weather events or seasonal effects.
  - Drastic increases in organic loadings (shock loads) which often originate with industrial sources.

Fixed Film Process Descriptions

A **Fixed Film Process** is a biological treatment process where the microorganisms attach themselves to structures known as media. The biodegradable organics are removed from the wastewater as it flows past and over the media containing the attached microorganisms.

Media is the material in a trickling filter on which slime accumulates and organisms grow.

Trickling Filter (TF)

- Water trickles downward over media made of stone or plastic.
- Plastic media comes in a variety of shapes and sizes.
- Media offers a place for aerobic bacteria to attach, multiply, and feed on the passing wastewater.

Rotating Biological Contactor (RBC)

- Rotating Biological Contractors have a rotating shaft surrounded by plastic disks (media) that allows microorganisms to grow.
- Media is rotated in and out of the wastewater to provide oxygen for organisms, which feed on the wastewater.

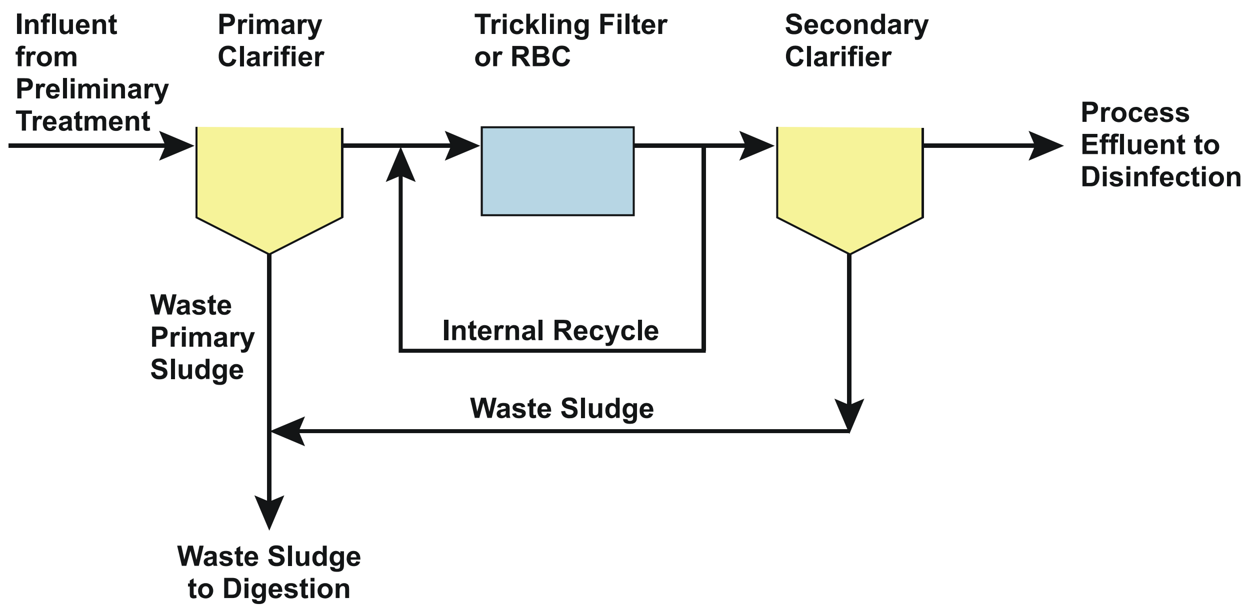

Figure 3.7 Fixed film biological treatment process

Suspended Growth Process Description

A **Suspended Growth Process** is a biological treatment process in which the microorganisms are suspended in the wastewater rather than physically attached to media. Oxygen is usually added to the suspended growth process to keep the biomass in suspension and to maintain aerobic conditions.

Activated Sludge

- The activated sludge process is a biological process into which oxygen is introduced that allows aerobic bacteria and other organisms to thrive and multiply.
- Biological treatment takes place in the aeration tanks where oxygen and wastewater is added to the biomass.
- Biodegradable organic matter is used by bacteria as a food source for producing new cells.
- Aeration tank contents, referred to as the Mixed Liquor Suspended Solids (MLSS), flows to secondary clarifier to separate the MLSS from the treated effluent.
- A portion of the settled MLSS containing microorganisms is returned to the aeration tank to continue the treatment process (Returned Activated Sludge).
- Left uncontrolled, the organisms become too great in number, so some must be periodically removed (Waste Activated Sludge).

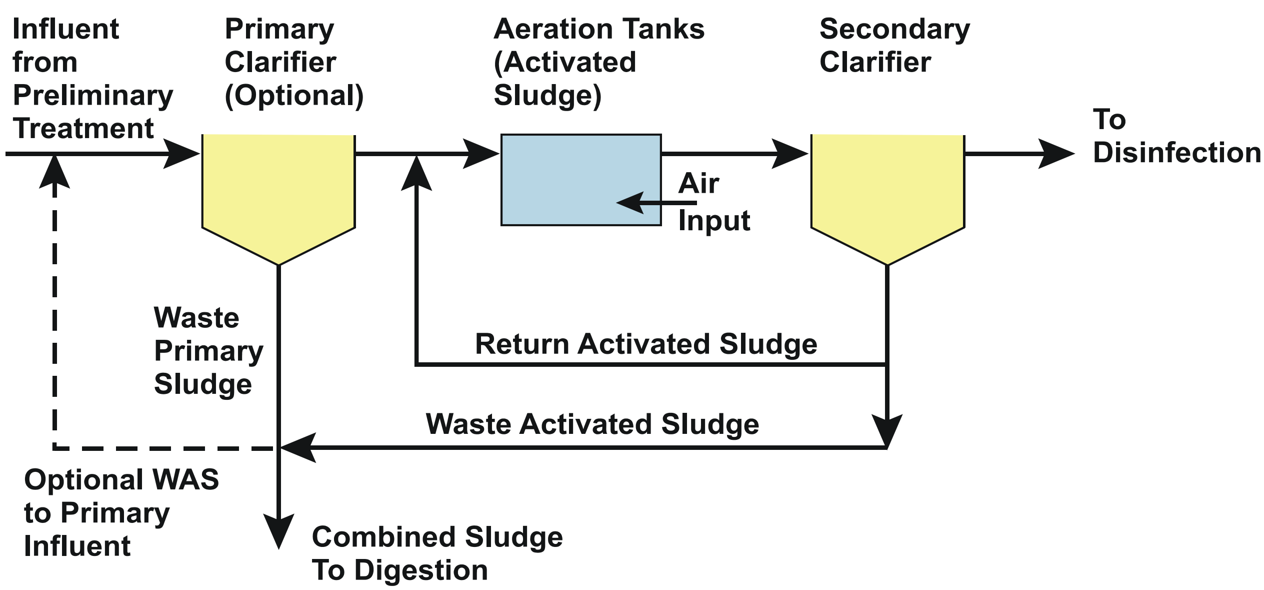

Figure 3.8 Suspended growth process schematic

Secondary Clarifiers

- Used with both fixed film and suspended growth technologies.
- Sludge containing live microorganisms is separated from liquid and settles to bottom of tank.
- A density current baffle may be installed to ensure currents are minimized (Figures 3.9 and 3.10) enhancing the performance of the clarifier. The baffle eliminates the effect created by density currents flowing up the clarifier wall. Density currents will prevent solids from settling properly and may allow solids to flow directly into the effluent trough.
  - The baffle is mounted on the wall of the clarifier below the effluent launder and scum baffle.
  - The baffle is designed to slope downward at an angle and extend towards the center of the tank beyond the scum baffle.
  - Flow is redirected inward and down toward the center of the tank improving settleability and preventing solids loss to the effluent trough.

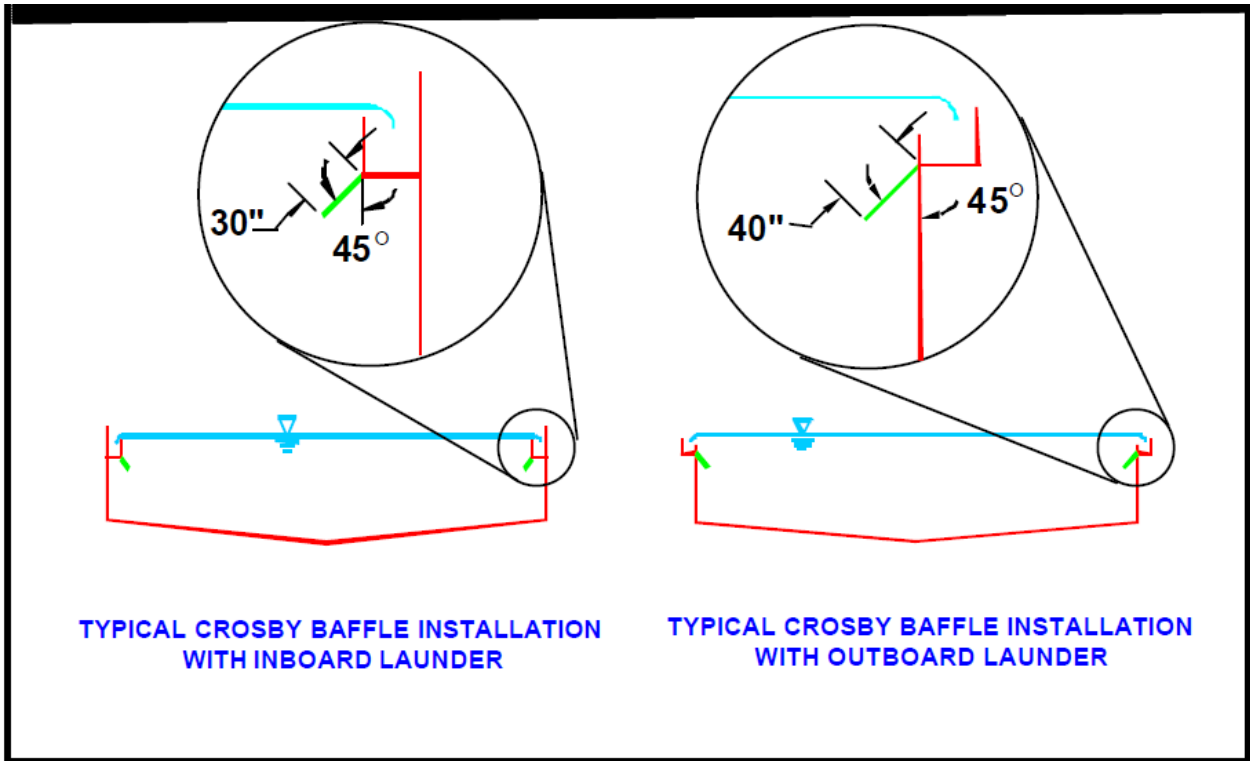

Figure 3.9 Current density baffle installations[9]

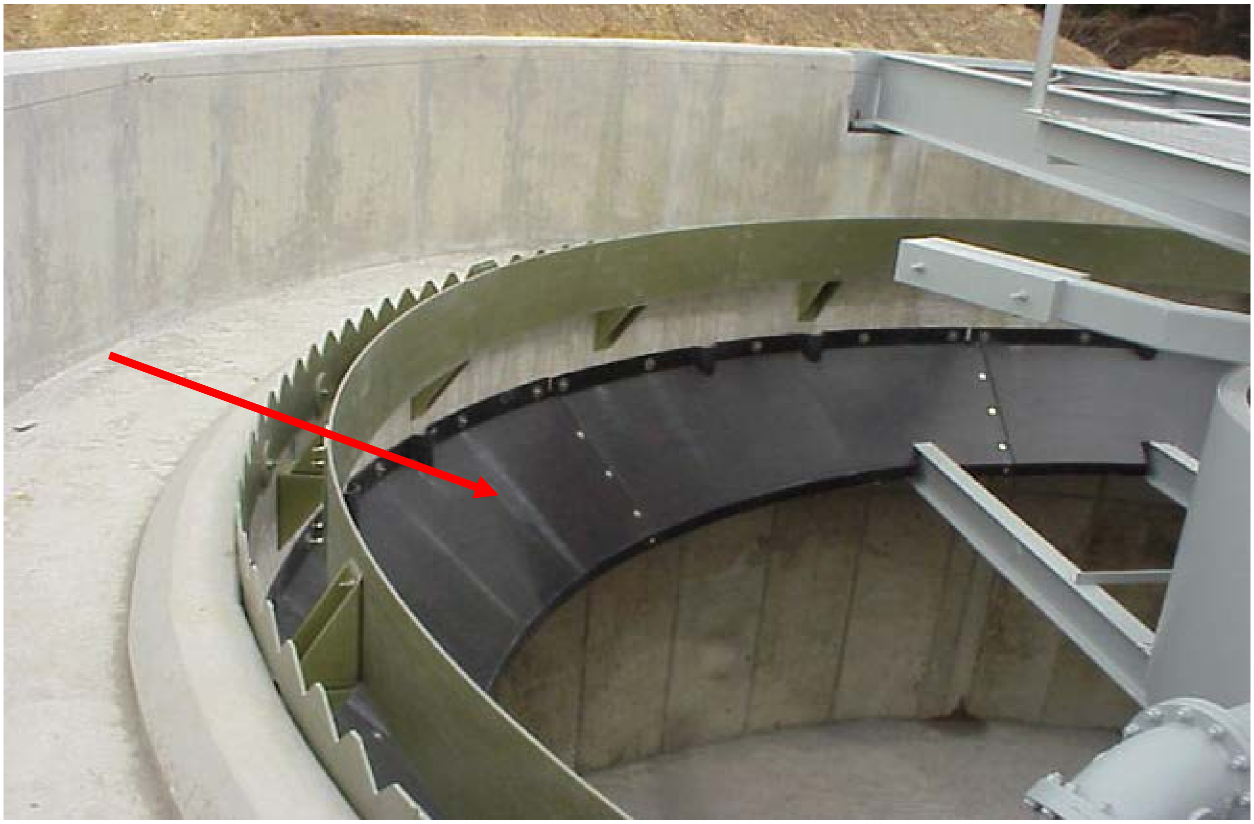

Figure 3.10 Density current baffle

- In an activated sludge process, a portion of the settled sludge is returned to the aeration tank as seed to maintain the biological treatment process, (Return Activated Sludge).
- Excess sludge is conveyed to the sludge handling processes for further treatment and ultimate disposal.
- The clarified effluent goes on to the disinfection process prior to discharge to the stream.

Why is a secondary clarifier needed after a trickling filter, rotating biological contractor, or aeration tank?[7]

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Waste Treatment Ponds

Purpose

- Achieve secondary (biological) treatment without all of the mechanical equipment and treatment units associated with the activated sludge process.

Types of Ponds

- Aerobic – shallow pond designed to treat wastewater under aerobic conditions. Oxygen is supplied by absorption at the water/air interface and through photosynthesis.
- Anaerobic – shallow pond designed to operate in the absence of dissolved oxygen. Anaerobic activity can generate odors, and is therefore not a popular choice for treatment in populated areas.
- Facultative – Combines aerobic and anaerobic treatment. Aerobic treatment occurs in the upper portion of the pond where oxygen is available from photosynthesis and absorption at the water/air interface. Solids which settle to the bottom of the pond are decomposed anaerobically.
- Aerated Pond – Similar to Facultative pond, except deeper, ranging in depth to 20 feet. Aerobic treatment occurs in upper portions of pond. Extended depth provided to allow for long-term storage of settled solids. Requires mechanical aeration to maintain aerobic conditions in upper portions of pond.

Process Description

Facultative Pond

- Similar to the conventional activated sludge process, but without aeration equipment, return and waste sludge pumping, digestion tanks, and secondary clarifiers.
- Land intensive—placement and use determined by design engineer based on economics and degree of treatment necessary.
- Settleable solids fall to bottom, begin to decompose aerobically. When dissolved oxygen is depleted, anaerobic bacteria continue decomposition on settled solids. Eventually, the remaining accumulated solids must be dredged from the pond.
- Methane and carbon dioxide rise to surface, some of which is used by algae that convert to oxygen through photosynthesis.
- Aerobic bacteria, algae and other microorganisms feed on dissolved solids in upper layer of pond and algae produce oxygen for other organisms to use.
- Performance varies seasonally as temperature and daylight hours vary.

Aerated Pond

- More suited for application in Pennsylvania.
- Generally has greater treatment capacity than traditional aerobic or facultative pond.
- As in other ponds, solids settle to bottom of pond where anaerobic decomposition occurs.
- Depth allows for long-term storage of solids. Designed typically for 10 years storage capacity. Solids decompose anaerobically over time. Greater volatile solids reductions are typical because of extended storage time.
- Aeration typically provided by floating mechanical surface aerators or by diffused aeration systems.
- Process can be enhanced by providing final clarifiers and return sludge capabilities, similar to the extended aeration activated sludge process.

Advanced/Tertiary Treatment Processes

Purpose

- Reduce the nutrient content of wastewater to prevent uncontrolled algae growth in lakes, reservoirs, or streams.

Processes for Nutrient Removal

Biological Phosphorus Removal

- Uses specific populations of microorganisms capable of using and storing phosphorus under anaerobic (no dissolved or bound oxygen present) conditions.
- Can be incorporated into the activated sludge process through the addition of an anaerobic zone ahead of the aeration zones.
- Increases phosphorus content in the waste sludge.

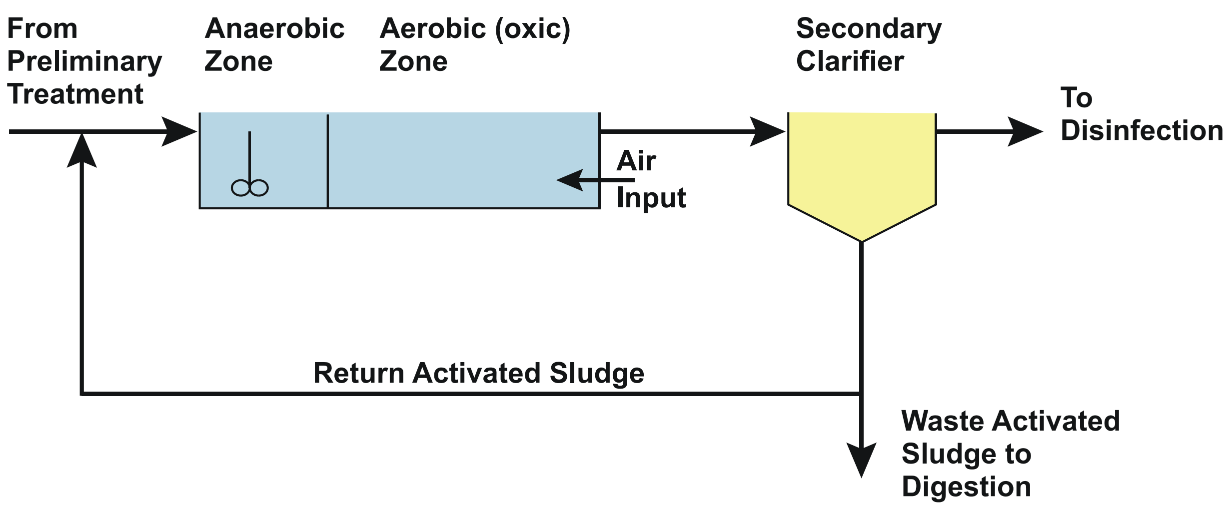

Figure 3.9 Biological phosphorus removal process schematic

Chemical Precipitation of Phosphorus

- Chemical addition process using aluminum or iron added to the aeration tank effluent ahead of the secondary clarifier to chemically bond to phosphorus.

- Metal-phosphorus compound settles out in secondary clarifier.

- Easy process to add on to existing activated sludge process. Does not require anaerobic zone.

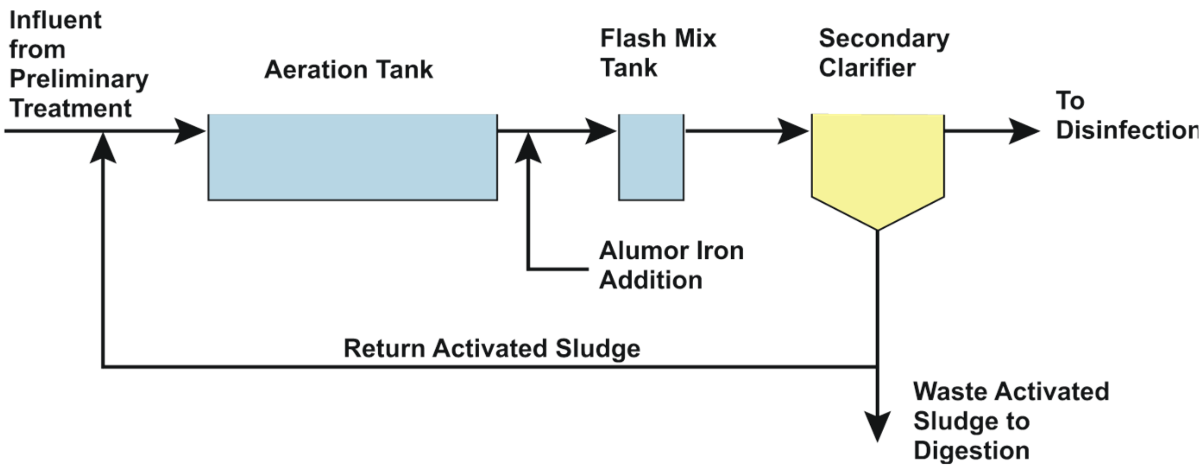

Figure 3.10 Chemical precipitation process schematic

Nitrogen Removal (Denitrification)

- Uses specific populations of organisms capable of using oxygen bound to other elements such as nitrate under anoxic conditions (no dissolved oxygen present).

- Requires another specific group of organisms to first convert ammonia present in the wastewater to nitrate in the aeration system before denitrification can take place.

- Denitrification can be incorporated into the activated sludge process units, or can be constructed as a stand-alone denitrification filters following secondary treatment.

- Can use carbon available in wastewater when incorporated into the activated sludge process.

- Denitrification filters following secondary treatment may require addition of a supplemental carbon source (methanol).

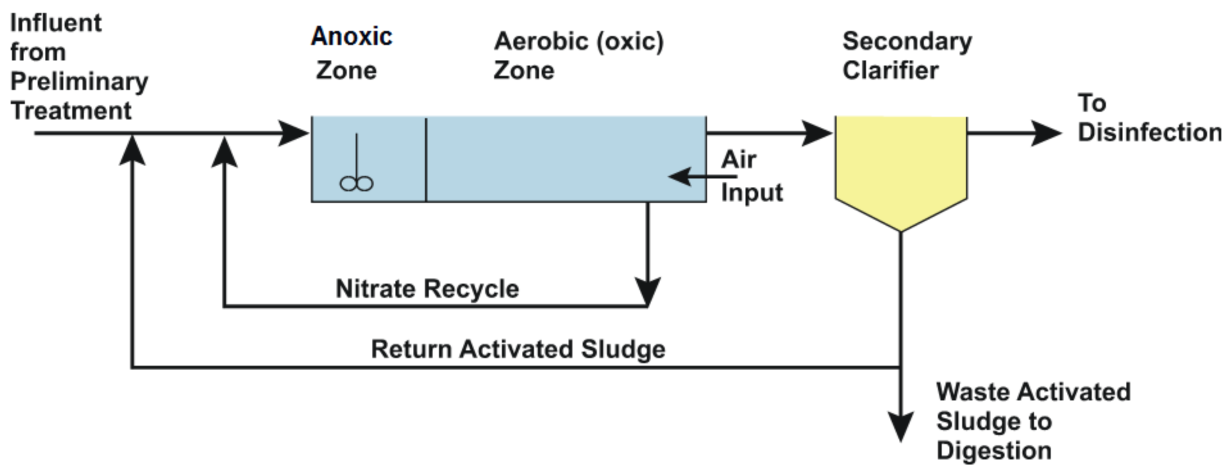

Figure 3.11 Denitrification process schematic.

Disinfection

Purpose

- Kill or inactivate pathogenic organisms in the treated effluent prior to discharge to the receiving stream.

Process Descriptions

Chlorination

- Chlorine solution can be generated from mixing chlorine gas with treated effluent or purchased commercially as sodium hypochlorite solution.
- Chlorine solution is added to clarified effluent from secondary clarifiers.
- Good initial mixing of chlorine solution and clarifier effluent is important to process efficiency.
- Effluent after addition of chlorine solution passes through “chlorine contact tank”. Tank provides detention time needed to insure contact of the disinfectant with the organisms.
- Contact tanks sized for a minimum of 30 minutes of hydraulic detention time at design annual average daily flow.

Detention time is the time required to fill a tank at a given flow or the theoretical time for a certain amount of wastewater to pass through a tank.[8]

Ultraviolet Light Radiation

- Effluent flows through banks of UV bulbs where UV radiation deactivates microorganisms.
- Does not require contact tank with 30 minutes detention time.
- Bulbs must be replaced periodically and cleaned regularly to maintain sufficient UV radiation.
- Does not have any residual disinfecting capabilities.

Solids Handling and Disposal

Purpose

- Remove and stabilize excess solids generated during the primary and secondary wastewater treatment processes.
- Reduce pathogens (Note: Pathogens are reduced, but not necessarily eliminated)

Stabilization Process Descriptions

Digestion

- Continued biological treatment of the sludge wasted from the primary and secondary treatment processes to reduce volatile solids (organic) content.
- Aerobic Digestion
    - Digestion carried out by aerobic bacteria in an aerated tank.
    - Capable of up to 50% reduction in volatile solids content.
    - Volatile Solid Reduction efficiency depends on temperature and on length of time sludge remains in the digester.
    - Does not generate a usable gas end-product such as the methane gas produced by anaerobic digestion process.
- Anaerobic Digestion
    - Digestion carried out by anaerobic bacteria in a heated, unaerated tank.
    - Capable of up to 50% reduction in volatile solids content, depending on temperature and length of time sludge remains in digestion.
    - For best efficiency, sludge in tank should be heated to 95°F.
    - Methane gas is generated by biological action of the bacteria. Acid forming bacteria consume the volatile organic solids creating organic acids. Methane-forming bacteria then convert the organic acids to methane gas.

Incineration

- Sludge can be burned when it does not pose an air pollution problem.

Wet Oxidation

- Method of treating sludge prior to water being removed.
- Air is introduced into liquid sludge and then heated and fed into pressure vessel where organic material is stabilized; the organic and inorganic material is then separated from vessel effluent by dewatering.

Lime Stabilization

- Lime slurry is added to untreated liquid sludge to raise the pH to 12.0 or higher.
- High pH prohibits additional biological activity in the sludge, thereby rendering it stable.

Post-Lime Stabilization

- Used to enhance or stabilize sludge after dewatering.
- Quicklime, calcium oxide (CaO), is blended with the dewatered sludge cake in a blending unit typically located at the discharge end of the dewatering equipment.
- Quicklime reacts with moisture remaining in the dewatered sludge cake to form calcium hydroxide ($Ca(OH)_2$. This reaction generates heat.
- The resulting calcium hydroxide raises the pH of the dewatered sludge to 12 or higher, depending on the lime dosage.
- High pH and elevated temperatures (140 to 150º F) inactivate pathogens and viruses, and render the dewatered sludge cake stabile from further decomposition.

Dewatering Technologies

- Typically follows digestion, and is necessary prior to incineration.
- Purpose is to remove water from the sludge to reduce overall volume.
- Solids content increases from 1 to 4% Total Solids to 15 to 20% Total Solids.
- Technologies
    - Belt filter press – mechanical, low energy required
    - Centrifuge – mechanical, high energy input required
    - Sludge drying beds – non-mechanical, no energy input; depends on gravity and evaporation

Three major components of a Wastewater System:

1. Collection/Conveyance
2. Treatment
3. Disposal

Stream Discharge

Most effluents are discharged to surface water.

- Treated effluent is a valuable source of additional water.
- Increased demand for water requires high degree of treatment of effluent.

Land Disposal

- Spray irrigation after treatment to remove the bulk of the BOD, suspended solids, and pathogens.
- Evaporation ponds are not practical in Pennsylvania climate

Unit 3 Exercise

1. What are the three major components of a Wastewater System?

   1. ______________________________
   2. ______________________________
   3. ______________________________

2. Name the three types of collection systems and briefly describe.

   1. ______________________________
   2. ______________________________
   3. ______________________________

3. Match the Treatment Processes with the correct description.

		Treatment Process	Description
___	1.	Preliminary Treatment	A. Sludge stabilization, pathogen reduction, and land application
___	2.	Primary Treatment	B. Biological treatment that produces acceptable effluent
___	3.	Secondary Treatment	C. Remove large debris by screening and degritting
___	4.	Solids Handling & Disposal	D. Eliminate dissolved and nonsettleable/colloidal organic material
___	5.	Waste Treatment Ponds	E. Inactivate pathogenic organisms
___	6.	Advanced/Tertiary Treatment	F. Remove settleable solids
___	7.	Disinfection	G. Reduce nutrient content to prevent algae growth

4. Gravity sewer systems are used when the slope is sufficient to produce __________ .
   a. 1 ft/sec
   b. 2 ft/sec
   c. 3 ft/sec
   d. 4 ft/sec

5. ________________________wastewater has a characteristic black color and is brought on by the action of anaerobic bacteria.

6. True or False: In preliminary treatment, grit channel cleaning results in a flow velocity decrease through the channel and an increase in removal efficiency.

7. Which of following are flow control devices:
   a. Weir
   b. Serial Rod
   c. Parshall Flume
   d. Kennison Nozzle

8. In a clarifier, the sludge that forms at the bottom may be referred to as the:
   a. Sludge cover
   b. Sludge level
   c. Sludge blanket
   d. Waste sludge

9. What type of settling tank typically follows the biological treatment step
   a. Primary clarifier
   b. Secondary clarifier
   c. Trickling filter
   d. Equalization tank

10. True or False: During clarification, large amounts of sludge rising to the surface may indicate that not enough sludge is being "wasted".

11. Advanced (tertiary treatment) is primarily intended remove which two inorganic contaminants:

    a. ______________________________

    b. ______________________________

12. Describe two methods of effluent disposal.

    1. ____
    2. ____

Key Points

- The three major components of a Wastewater System are: Collection, Treatment and Disposal.
- Treatment processes include: Preliminary Treatment, Primary Treatment, Secondary Treatment, Tertiary (Advanced) Treatment, Disinfection and Solids Treatment.
- Two types of Secondary Treatment include: Fixed Film and Suspended Growth.
- Waste Treatment Ponds are alternatives that can achieve secondary treatment results when operated under the appropriate conditions.
- Tertiary (Advanced) Treatment reduces nutrients that can cause excess algae growth, low dissolved oxygen and in severe cases eutrophication in the receiving stream.
- Disinfection inactivates pathogenic organisms prior to discharge.
- Digestion of solids (sludge) is a process that renders solids “stable”.

References

[1] John Brady and William Crooks, “Chapter 3: Wastewater Treatment Facilities,” in *Operation of Wastewater Treatment Plants*, Vol. 1, (Sacramento, CA: California State University, Sacramento Foundation, 1998), p. 32.

[2] Brady, p. 40.

[3] Brady, p. 41.

[4] Brady, p. 41.

[5] Brady, p. 30.

[6] Brady, p. 43.

[7] Brady, p. 47.

[8] Brady, p. 29.

[9] *Wet Weather Operating Practices for POTWs with Combined Sewers, Technology Transfer Document*, NY State Department of Environmental Conservation, Stearns & Wheler, LLC 11-07.

Unit 4 – State and Federal Regulations

Learning Objectives

- List the purpose of the Drinking Water and Wastewater Systems Operators' Certification Program
- Identify the classifications and sub-classifications for wastewater operator licenses under the Water/Wastewater Certification Act (Act 11 of 2002) and Chapter 302
- List the responsibilities of a licensed operator under Chapter 302
- Identify and locate state and federal regulations that govern wastewater treatment

Drinking Water and Wastewater Systems Operators' Certification Program

The purpose of the Drinking Water and Wastewater Systems Operators' Certification Program is to protect public health, safety, and the environment and promote the long-term sustainability of the Commonwealth's drinking water and wastewater treatment systems.

- Act 11 of 2002 signed into law by Governor Mark Schweiker on Feb 21, 2002.
- Chapter 302 published as final in the Pennsylvania Bulletin on Sept. 18, 2010. There are a few things that changed as a result of the new regulations. These include:
    - creation of a laboratory supervisor subclassification
    - requirement that a general work plan and/or a system specific management plan be developed for circuit rider systems
    - successful completion of Securing Drinking Water and Wastewater Treatment Facilities security training course by every certified operator
    - accelerated certification
    - new fees to cover the costs for program implementation

The Drinking Water and Wastewater Systems Operator Certification Program Handbook was developed to assist operators and system owners in understanding program elements. Inside this handbook you will find the following:

- Introduction and background information on the Operator Certification Program
- Requirements and activities associated with becoming a certified operator
- The process for applying for a certificate
- Certificate renewal and continuing education requirements
- Grandparenting provisions for operators
- System classes and subclassifications
- System operation and process control
- Using DEP's Operator Information Center website

The appendices also contain helpful information and templates, including the need-to-know criteria for examinations, definitions of classes and subclasses, a template for an operator report to the system owner, example templates for Standard Operating Procedures, an example process control plan template, and circuit rider work plans and management plan templates.

Examination Requirements

No experience or training is required to sit for the certification examinations. Therefore, anyone (laborer, maintenance worker, working operator) can apply, pay the fee and sit for the certification examination. Be aware that if the applicant passes the examinations he/she is still not officially certified in that they must obtain the necessary minimum experience requirements. Final approval will be granted after a thorough review of the applicant's information and official approval by the Board.

- Exam given in two parts except for Class E, subclass 4:
  - Part I – General information covering basic knowledge of wastewater system operations.
  - Part II – Specific knowledge areas related to wastewater treatment technology.
  - Stand-alone Class E (Collections) – Collection system examination only. Examinees are NOT required to take the Part 1 – general exam.

Classifications and Sub-classifications

Wastewater Classifications

- A – greater than 5 million gallons per day (mgd)
- B – less than 5 mgd, but greater than 1 mgd
- C – less than 1 mgd, but greater than 0.1 mgd
- D – less than 0.1 mgd
- E – Satellite wastewater collection systems with pumping stations

Wastewater Sub-classifications

- 1 – Activated Sludge/Extended Aeration and Sequencing Batch Reactors
- 2 – Treatment Ponds/Lagoons
- 3 – Trickling Filters and Rotating Biological Contactors
- 4 – Single Entity Wastewater Collection Systems

Classification	High School Diploma or GED	CP	ASP	AS	BS/BA
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

Figure 4.2 Experience requirements for certification.

CP: A DEP-approved Certification Program in Wastewater Treatment
ASP: An Associate Degree in a Wastewater Treatment Program approved by DEP
AS: Associate Degree in environmental or physical sciences, engineering or engineering technology NOT approved by DEP
BS/BA: A bachelor's or graduate degree in Biology, Chemistry, Environmental Sciences, Physical Sciences, Sanitary or Environmental Engineering or Engineering Technology from a nationally accredited college or university

Education/Experience Substitution (for High School Diploma or GED ONLY)

Education/Experience	Total Experience Allowed
Successful completion of every 10 hours of post high school or post GED water or wastewater related training (as applicable) approved by DEP and determined by the State Board for Certification of Water and Wastewater Systems Operators (Board) to be applicable to the certification sought.	1 month experience per 10 hours of training.
Successful completion of a college course approved by DEP as being specifically applicable to the water or wastewater disciplines (Each college credit is equivalent to 15 hours.)	1.5 months experience for each college credit.

Criminal Record Check

All applications for certification or recertification must be accompanied by a criminal history record.

- Apply to the PA State Police using form SP4-164 (Download the Criminal History Request Form - SP4-164)
- $10.00 fee, as certified check or money order (cash or personal check not acceptable).
- Allow 4 weeks for processing request.
- This report may also be obtained electronically through the Pennsylvania State Police Website at https://epatch.state.pa.us/Home.jsp (requires a credit card).
- This report must be dated within 90 days of the date the application is received by the State Board for Certification of Water and Wastewater Systems Operators.
- Decisions for revoking a license based on the Criminal History record are handled by the State Board for Certification of Water and Wastewater System Operators.

Tips for completing form SP4-164

- DO NOT select block to review your entire criminal history. This will include arrests and convictions—only need to report convictions. Selecting block could delay receipt of report.
- In "Reason for Request" area, select "Other" and specify "wastewater operator certification requirement."

Training and Continuing Education

Required Hours per Renewal Cycle (see Figure 4.1)

- Credit hours must be earned within the 3-year renewal period.
- Cannot carry-over "extra" credit hours earned from one renewal period into the next period.
- Credit hours can only be earned from DEP approved courses.

Operator Class	Contact Hours First 3-Yr Cycle	Contact Hours Subsequent 3-Yr Cycles
A	15	30
B	15	30
C	15	30
D	8	15
E (Collection)	8	15
Grandparented	8	15

Figure 4.1 Continuing education requirements for certified wastewater operators.

Certified Operator's Duties and Responsibilities under the Regulations

Meet the Requirements for Recertification

- Complete continuing education requirements
- Submit proper forms and fees

Report to the System Owner Any Known Violations or Conditions that May Cause Violations

- System owner must provide operator with copy of permit.
- Operator must be familiar with permit requirements as well as regulations impacting system operation.

What are examples of conditions that cause violations?

Develop and Implement Operations and Maintenance Planning

- Preventive maintenance program
- Emergency planning
- Process control strategies
- Process monitoring strategies

Report to the System Owner Actions Necessary to Prevent or Eliminate Violation of Regulations or Permit

- Provide written reports to owner outlining actions taken or recommended to mitigate or prevent violations.
- Keep copies of all reports.

Make Process Control Decisions, or Direct Actions Related to Process Control

Process Control Decision is a decision that maintains or changes water quality or quantity of a water or wastewater system in a manner that may effect public health or the environment.

- Only certified licensed operator can make process control decisions.
- Examples of Process Control Decisions:
  - Adjusting chemical feed rates
  - Starting or stopping recycle flows
  - Adjusting flow through process units
  - Placing a treatment unit in service or taking a unit out of service

- Non-certified operators can follow standard operating procedures (SOPs) for carrying out specific actions related to plant operation and process control.
- Standard operating procedures are good for tasks that do not require data interpretation or judgment such as:
  - Mixing a chemical batch (i.e. polymer) that is always mixed to the same solution strength.
  - Routine equipment or process unit maintenance procedures.

- Standard operating procedures must be written and approved by the certified operator for the system. The certified operator must still be available for process control decisions.

What are some other examples of tasks that would be good candidates for a Standard Operating Procedure?

Penalties and Enforcement

Violations

- Making process control decisions without first obtaining a valid operator's certification.
- Failing to comply with any of the responsibilities and duties of a certified operator contained in Section 13 of the Act.
- Failure to comply with a DEP order issued under Section 4(b)(1.1) of the Act.

Penalties

- Summary offense—fine of not less than $50 nor more than $500
- Civil Penalty
  - Whether or not the violation was willful or as a result of negligence on the part of the operator.
  - Penalty amount to be commensurate with the type, severity, and frequency of the violation and its measurable impact on the environment or on public health up to a maximum of $1000 per day for each violation.
- Payment due within 30 days, unless an official written appeal is filed with the Environmental Hearing Board within the 30 day period after the notification of the penalty.
- Failure to file an appeal within the 30 days of the assessment will result in a waiver of all legal rights to contest the violation or the amount of the penalty.

Role of the State Board for Certification

- Board consists of the Secretary of DEP, or designated representative, and six (6) additional members appointed by the Governor.

- Duties include:
  - Review and act on all applications for certification, recertification, and renewals, including a review of the state police criminal history report for all applicants.
  - Administer examinations for certification and recertification.
  - Revoke, suspend, modify, or reinstate certificates upon petition of DEP.
  - Receive and act upon complaints.
  - Review, provide written comments, and make recommendations to DEP on rules and regulations prior to submission of those rules and regulations to the Environmental Quality Board.
  - Issue written orders.
  - Adopt bylaws.
  - Collect fees for examinations and applications for certification, recertification, and renewals.
  - Approve or disapprove DEP decisions regarding training for certification and continuing education.

NPDES Program

A National Pollutant Discharge Elimination System (NPDES) permit is required for any point source discharge to waters of the Commonwealth. The Regional Clean Water Programs of DEP issue the majority of NPDES permits for sewage.

Permits regulate discharges with the goals of 1) protecting public health and aquatic life, and 2) assuring that every facility treats wastewater. To achieve these ends, permits include the following terms and conditions:

- Monitoring and reporting requirements, including site-specific discharge (or effluent) limits;
- Standard and site-specific management, compliance monitoring and reporting requirements; and
- When and if regulated facilities fail to comply with the provisions of their permits, they may be subject to enforcement actions. DEP and EPA use a variety of techniques to monitor permittees' compliance status, including on-site inspections and review of data submitted by permittees.

Discharge Monitoring Reports

Discharge Monitoring Reports (DMRs) are reports that contain self-monitoring results for wastewater required by NPDES permits and some Water Quality Management (WQM) permits. These reports are completed and submitted periodically to DEP and other agencies (typically monthly, quarterly, semi-annually or annually). DMRs may be submitted on paper to DEP regional offices or electronically through DEP's eDMR system.

DMRs must be submitted by any facility that has been issued an NPDES permit that requires sampling and monitoring (typically sewage treatment plants and industrial facilities with a wastewater or storm water discharge to surface waters). DMRs may also be required for WQM permits with land application of effluent.

DMRs include all test results and if there are violations, an explanation of the issue and corrective actions taken.

EPA Regulations

40 CFR 122 – EPA Administrative Regulations for the NPDES Permit Program

- Authorized under Sections 318, 402, and 405 of the federal Clean Water Act.
- Requires that no discharge may occur without a NPDES permit (122.4).
- Requirements for continuation of an expiring permit (122.6).
- Criteria for confidentiality of information (122.7).

- Requirements for applications for new permits and renewals (122.21).

40 CFR 125 – Criteria and Standards for NPDES Permits

- Authorized under Sections 301 and 402 of the federal Clean Water Act.
- Establishes technology-based treatment requirements for NPDES permits (125.3).
- Regulations for attaining and maintaining water quality, assuring protection of public water supplies, wildlife propagation, and allowing recreational activities (125.62).
- Regulations regarding urban area pretreatment programs (125.65).
- Requirements for Toxics control programs (125.66).

40 CFR 133 – Secondary Treatment Regulations

- Defines secondary treatment (133.101).
- Establishes level of treatment attainable through secondary treatment (133.102).
- Establishes regulations regarding required sampling and test procedures (133.104).
- Establishes criteria for treatment equivalent to secondary treatment (133.105).

40 CFR 136 – Guidelines Establishing Test Procedures for the Analysis of Pollutants

- Lists the approved analytical procedures for wastewater analyses.
- Lists the approved sample holding times and preservation techniques.
- All testing performed in accordance with the monitoring requirements for the NPDES permit must be done in accordance with the procedures listed in 40 CFR 136.

Pennsylvania State Regulations

Title 25 Chapter 92a – NPDES Regulations

- Authorized under section 5 and 402 of the Pennsylvania Clean Streams Law (35 P.S. § § 691.5(b)(1) and 691.402).
- Establishes NPDES General Program Requirements for PA (92a.2 – 92a.12).
- Establishes Discharge Permit Application Procedures and Special NPDES Program Requirements (92a.21 – 92a.36).
- Defines Permits and Permit Conditions (92a.41 – 92a.55).
- Establishes Monitoring and Annual Fee Requirements (92a.61 and 92a.62).
- Regulates Transfer, Modification, Revocation and Reissuance, Termination of Permits, Reissuance of Expiring Permits and Cessation of Discharge (92a.71 - 92a.76).
- Identifies Civil Penalties for Violations of NPDES Permits (92a.101-.92a.104).

Industrial Pre-Treatment EPA Regulations

40 CFR 401 – The Federal Pretreatment Program

- Authorized by sections 301, 304, 306, and 501 of the federal Clean Water Act.
- Sets forth legal authority and general definitions which apply to all regulations issued concerning specific classes and categories of point sources under parts 402 through 699.
- Law authorizing establishment of effluent limitations guidelines for existing sources, standards of performance for new sources, and pretreatment standards of new and existing sources (401.12).
- Test procedures for measurement (401.13).
- Toxic pollutants (401.15).
- Conventional pollutants (401.16).
- pH limitations under continuous monitoring (401.17).

40 CFR 403 – General Pretreatment Regulations for Existing and New Sources

- Authorized by sections 204, 208, 301, 304, 307, 308, 309, 402, 405, and 501 of the Federal Water Pollution Control Act, as amended by the Clean Water Act of 1977.
- National Pretreatment Standards: Prohibited discharges (403.5).
- National Pretreatment Standards: Categorical Standards (403.6).
- Revision of categorical pretreatment standards to reflect POTW removal of pollutants (403.7).
- POTW pretreatment programs: development by POTW (403.8).
- Approval procedures for POTW pretreatment programs (403.11).
- Reporting requirements for POTWs and industrial users (403.12).

Biosolids EPA Regulations

40 CFR 503 – Standards for the Use or Disposal of Sewage Sludge

- Establishes general requirements, pollutant limits, management practices, and operational standards for the recycling or disposal of sewage sludge.
- Applies to sludges that are applied to farmland or used for land reclamation, placed in a surface disposal site, or fired in an incinerator.
- Includes monitoring and reporting requirements.
- Includes vector attraction and pathogen reduction requirement.
- Information available on EPA website at www.epa.gov

Biosolids Pennsylvania State Regulations

25 Pa Code Section 271 – Subchapter J – Beneficial Use of Sewage Sludge by Land Application (January, 1997)

- Established expiration dates for individual site-specific permits created under Section 275.
- Revised the permitting process from individual site-specific permits to general permit.
- Established levels of General Permits for land application of sewage sludge.
  - PAG-07 Exceptional Quality biosolids (Class A biosolids under 40 CFR 503)
  - PAG-08 Non-exceptional Quality biosolids (Class B Biosolids under 40 CFR 503)
  - PAG-09 Residential Septage
- Established operating requirements for land application of biosolids.
  - General Requirements (271.913)
  - Pollutant Limits (271.914)
  - Management Practices (271.915)
  - Operational Standards for pathogen and vector attraction reduction (271.916)
  - Monitoring requirements (271.917)
  - Recordkeeping requirements (271.918)
  - Reporting requirements (271.919)
  - Inspection by DEP (271.920)
  - Sewage sludge quality enhancement plan (271.921)—requires sewage sludge generator to evaluate ways to improve biosolids quality
- Defines methods to achieve satisfactory pathogen and vector attraction reduction (271.931 – 933).
- Information and guidance for biosolids accessible through the DEP website at www.depweb.state.pa.us
- There are also links to the biosolids web page from the DEP wastewater operators' page.

Overview of Act 537

- Enacted in 1966; serves as the basis for wastewater planning in PA.
- Requires that all municipalities develop and maintain an up-to-date sewage facilities plan.
- Controls manner in which wastewater is handled in the community.
- Planning consists of:
    - Identifying areas where on-lot systems are capable of supporting wastewater disposal.
    - Identifying areas where on-lot systems are malfunctioning and require renovation.
    - Identifying areas where public collection and treatment systems are required to protect public health and the environment—"Needs Areas."
    - Identifying the most cost effective technologies for accommodating the planning needs of the community.
    - Identifying financing and the impact on user fees for the construction of new sewage handling facilities.
    - Scheduling the phasing and construction of new facilities.
    - Adopting legal authority for managing existing/remaining on-lot systems areas.
- Planning costs are 50% reimbursable upon approval of the final plan by DEP.

25 PA Code Chapter 94

- Authorized by Section 5 of the Clean Streams Law.
- Defines hydraulic and organic capacity.
- Defines hydraulic and organic overloading conditions.
- Establishes corrective action to be taken when overloading conditions exist or are projected to occur.
- Requires a report annually that examines current hydraulic and organic loadings and identifies existing or projected overloading conditions in the collection and conveyance systems as well as treatment facilities.
- Serves as basis for planning modules.
- Tracks industrial pretreatment programs.

25 Pa Code Chapter 93 – Pennsylvania Water Quality Standards

- Authorized under section 5 and 402 of the Pa Clean Streams Law.
- Used by DEP in setting effluent limits.
- Protected Water Uses (93.3).
- Statewide Water Uses and Anti-degradation criteria (93.4, 93.4a – 93.4d).
- General Water Quality Criteria (93.6).
- Specific Water Quality Criteria (93.7).
- Site Specific Water Quality Criteria Development (93.8).
- Toxic Substances (93.8a).
- Designated water uses and water quality criteria, per Drainage List (93.9 a – 93.9z).

25 Pa Code Chapter 16 – Water Quality Toxics Management Strategy

- Guidelines for development of aquatic life criteria (16.21 – 16.24).
  - Acute and chronic toxicity criteria
  - Metals criteria
- Guidelines for development of human health based criteria (16.31 – 16.33).
  - Threshold level toxic effects
  - Non-threshold effects (cancer)
- Water quality criteria for toxic substances (16.51 – 16.52).
  - Human health and aquatic life criteria
  - Whole effluent toxicity testing

Key Points

- Act 11, the Operator Certification Act, directly affects operators by setting license classifications and sub-classifications, establishing continuing education requirements and setting examination requirements

- Chapter 302, Administration of the Water and Wastewater Systems Operators' Certification Program was published as final in the Pennsylvania Bulletin on Sept. 18, 2010.

- NPDES regulations are governed by EPA and Pennsylvania

- Act 503 governs the handling of Biosolids

- Act 537 deals primarily with on-site systems, but established the management of sewer systems, particularly in the area of capacity and the needs of the community.

Unit 4 Exercise

1. Which of the following are requirements to become a certified operator?

    a. At least a high school education
    b. Recent doctor physical
    c. Pass the appropriate exams
    d. Meet the experience requirement

2. **True/False:** A non-certified operator can complete process control decisions in accordance with an approved standard operating procedure.

3. Which of the following are examples of process control decisions:

    a. Decision to allow overtime to run the plant manually on the weekend
    b. Diverting flow to another treatment train
    c. Increasing waste activated sludge (WAS) rate
    d. Decision by a non-certified operator to increase the chlorine dosage by following an approved standard operating procedure (SOP).

4. Wastewater facilities require a ____________________ permit to discharge to the waters of the Commonwealth.

5. NPDES permits contain information on which of the following:

    a. Site-specific discharge limits
    b. Compliance monitoring and reporting requirements
    c. Maintenance requirements
    d. Standard operating procedures

6. **True/False:** Discharge Monitoring Reports are only submitted to DEP if there is an effluent violation.

7. Which one of the following has the power to revoke an operator's license:

    a. System manager
    b. System supervisor
    c. DEP Certification Section
    d. State Board for Certification