

# Wastewater Treatment Plant Operator Certification Training Instructor Guide



## Module 24: Wastewater Collection Systems – Part II

This course includes content developed by the Pennsylvania Department of Environmental Protection (Pa. DEP) in cooperation with the following contractors, subcontractors, or grantees:

The Pennsylvania State Association of Township Supervisors (PSATS)  
Gannett Fleming, Inc.  
Dering Consulting Group  
Penn State Harrisburg Environmental Training Center



## A Note to the Instructor

Dear Instructor:

The primary purpose of this course, *Wastewater Collection Systems – Part II*, is to provide an overview of the different types of pumping stations, their components and the regulatory requirements associated with pumping stations. The module also covers the operation and management and safety procedures related to collection systems. This module has been designed to be completed in approximately 3 hours, but the actual course length will depend upon content and delivery modifications and results of course dry runs performed by the approved DEP sponsor. The number of contact hours of credit assigned to this course is based upon the contact hours approved by the Pa. DEP under DEP’s course approval process. To help you prepare a personal lesson plan, timeframes have been included in the instructor guide at the Unit level and at the Roman numeral level of the topical outline. You may need to adjust these timeframes as necessary to match course content and delivery modifications made by the sponsor. Please make sure that all teaching points are covered and that the course is delivered as approved by DEP.

Web site URLs and other references are subject to change, and it is the training sponsor’s responsibility to keep such references up to date.












Delivery methods to be used for this course include:

- Lecture
- Unit Exercise

To present this module, you will need the following materials:

- One workbook per participant
- Extra pencils
- Laptop (loaded with PowerPoint) and an LCD projector **or** overheads of presentation and an overhead projector
- Screen
- Flip Chart
- Markers

Icons to become familiar with include:

Participant Workbook	Instructor Guide
 Exercise/Activity	Same icons for Participant Workbook apply to the Instructor Guide.
 Case Study	<b>Ans:</b> Answer to exercise, case study, discussion, question, etc.
 Discussion Question	 PowerPoint Slide
 Calculation(s)	 Overhead
 Unit Exercise	 Flip Chart
 Key Definition(s)	 Suggested “Script”
 Key Point(s)	

Instructor text that is meant to be general instructions for the instructor are designated by being written in script font and enclosed in brackets. For example:

*[Ask participants if they have any questions on how to read the table. Answer any questions participants may have about how to read the table.]*

If your module includes the use of a PowerPoint presentation, below are some helpful controls that you may use within the Slide Show.



### **PowerPoint Slide Show Controls**

You can use the following shortcuts while running your slide show in full-screen mode.

<b>To</b>	<b>Press</b>
Advance to the next slide	N, ENTER, or the SPACEBAR (or click the mouse)
Return to the previous slide	P or BACKSPACE
Go to slide <number>	<number>+ENTER
Display a black screen, or return to the slide show from a black screen	B
Display a white screen, or return to the slide show from a white screen	W
Stop or restart an automatic slide show	S
End a slide show	ESC
Return to the first slide	Both mouse buttons for 2 seconds
Change the pointer to a pen	CTRL+P
Change the pen to a pointer	CTRL+A
Hide the pointer and button temporarily	CTRL+H
Hide the pointer and button always	CTRL+L
Display the shortcut menu	SHIFT+F10 (or right-click)
Erase on-screen annotations	E
Go to next hidden slide	H
Set new timings while rehearsing	T
Use original timings while rehearsing	O
Use mouse-click to advance while rehearsing	M

## INSTRUCTOR GUIDE

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### INTRODUCTION OF MODULE: 5 minutes



Display Slide 1—Module 24: Wastewater Collection Systems – Part II.

*[Welcome participants to “Module 24 – Wastewater Collection Systems – Part II.” Indicate the primary purpose of this course is to provide an overview of the different types of pumping stations, their components and the regulatory requirements associated with pumping stations. The module also covers the operation and management and safety procedures related to collection systems.]*

*[Introduce yourself.]*

*[Provide a brief overview of the module.]*



This module contains 3 units. On page i, you will see the topical outline for **Unit 1 – Overview of Pumping Stations** and **Unit 2 – Management and Operations of Pumping Stations**.

*[Briefly review outline.]*



If you turn the page, you will see the topical outline for **Unit 3 – Safety**.

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*[Continue to briefly review outline.]*

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### UNIT 1: 70 minutes



Display Slide 2—Unit 1: Overview of Pumping Stations.



At the end of this unit, you should be able to:

- List three types of pumping stations, describe how each operates and explain the ideal conditions needed for each station to operate properly.
- Explain the standards and permitting requirements that apply to pumping stations.
- List and describe the components of pumping stations.

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TYPES OF PUMPING STATIONS: 15 minutes



There are three different types of pumping stations we will review in this module: the wet well/dry well, the submersible pumping station and the vacuum pumping station.

### Wet Well/Dry Well

*[Review the information in the workbook.]*



Display Slide 3—A Wet Well/Dry Well.



In this graphic, the wet well is on the left of the figure and the dry well is on the right. The graphic is illustrating that the wet well is a separate structure from the dry well. The wet well is basically a manhole or vault where the influent wastewater enters and the dry well holds the pump that pumps the wastewater out of the wet well to the force main.



### Submersible



The second type of pumping station is the submersible pumping station.

*[Review the information in the workbook.]*



Display Slide 4—A Submersible Pumping Station.



The submersible pumping station is a pumping station in which the pumps are located underground in the wet well. You can see this in this illustration. In this type of pumping station, there is only one structure.

### Vacuum



The final type of pumping station is the vacuum pumping station.

*[Review the information in the workbook].*



Display Slide 5—A Vacuum Pumping Station.



This slide shows what the layout of a vacuum pumping station looks like. Since this type of pumping station is not typically used in our state, we will not review this diagram in detail. It has been provided just to give you an idea of how this type of pumping station is laid out. Vacuum pumping stations are typically used in the southern U.S. in flat coastal areas. They cannot be used where there is hilly terrain, which is why they are not used in Pennsylvania.

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REGULATORY REQUIREMENTS: 10 minutes



In this next section, we will discuss some of the standards and permitting requirements associated with the operation of a pumping station. Let's start by talking about some of the general standards that exist for pumping stations. After that, we will talk about some of the standards that exist for the specific types of pumping stations.

### **Standards**

*[Review the information in the workbook.]*

*[Review the remaining information in the workbook.]*

### **Permitting**

*[Review the information in the workbook.]*

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COMPONENTS: 45 minutes



We will spend the remainder of this unit discussing the components of pumping stations, beginning with wet wells.

### **Wet Wells**

*[Review the information in the workbook.]*

### **Dry Wells**



Next is the dry well.

*[Review the information in the workbook.]*

### Electrical Systems



The next component is the electrical system.

*[Review the information in the workbook.]*



Display Slide 6—A Typical Pump Station Electrical System.



This slide illustrates the electrical system. Let's look at it as we review the components of the system which are listed on the next page.

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*[Review the components of the electrical system listed in the workbook and point out each component on Slide 6 as you review it].*

### **Controls**



The controls are the next component we will discuss. There are four types of controls we will focus on: float controllers, level transducers, ultrasonic level detectors and air bubblers.

### **Float Controllers**

*[Review the information in the workbook].*

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*[Review the remaining information in the workbook on float controllers.]*

### **Level Transducers**

*[Review the information in the workbook.]*

### **Ultrasonic Level Detectors**

*[Review the information in the workbook.]*

### **Air Bubblers**

*[Review the information in the workbook.]*



### Pumps/Motors



Another essential component of a pumping station is the pump and the motors. There are two types of pumps we will learn about: centrifugal pumps and positive displacement pumps.

*[Review the information in the workbook.]*

#### Centrifugal Pumps

*[Review the information in the workbook.]*

#### Positive Displacement Pumps

*[Review the information in the workbook.]*

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### General Overview of Pump Hydraulics



Let's spend a few minutes talking about pump hydraulics.

*[Review the information in the workbook.]*



Review the definitions listed in the workbook.

### Valves



The final component is the valves. There are three types of valves: gate valves, plug valves and check valves.

#### Gate Valves

*[Review the information in the workbook.]*



Display Slide 7—Gate Valves.



This slide shows one of the most common types of valves which is a gate valve in which disc or gates are used to provide a shutoff. These discs are shown in the bottom half of the illustration. On the left side, the valve is assembled and on the right side, the valve has been separated.

### Plug Valves



Our next type of valve is the plug valve.

*[Review the information in the workbook.]*



Display Slide 8—Opening and Closing of a Plug Valve.



Plug valves are used as suction and discharge isolation valves. This slide shows the open, closing and closed positions of a plug valve. In the open position, the plug normally resides in the side of the valve and is out of the flow. When it is in the closed position, the plug seats up against the valve body and provides a positive shutoff.

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Display Slide 9—A Plug Valve.



This slide shows the components of a plug valve. Basically, a plug valve consists of the valve body and a rotating plug that operates through 90 degrees.

### Check Valves



The final type of valve is the check valve.

*[Review the information in the workbook].*



Display Slide 10—A Check Valve.



On this slide we see the most common type of check valve which is a swing check valve. This valve consists of a valve body with a clapper arm attached to a hinge that opens when the pump comes on and closes to seat when the pump is shut off.

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*[Review the Key Points for Unit 1 – Overview of Pumping Stations.]*

**Exercise**

1. List three types of pumping stations and explain when each is used.

a. wet well/dry well – for high flows.

b. submersible – for low flows and high heads.

c. vacuum – not typical in PA – used mostly in flat coastal areas of southern U.S.

2. What is the difference between a centrifugal pump and a positive displacement pump?

A centrifugal pump produces high velocity kinetic energy and converts it to pressure. A positive displacement pump produces pressure by applying force directly to the fluid.

3. List three types of valves and explain when each is used.

a. Gate valves are located immediately before and after pumps to facilitate maintenance by isolating the pump from the wet well and the force main.

b. Plug valves are less susceptible to clogging and are also used to isolate the pump from the wet well and the force main.

c. Check valves are typically installed in the discharge of each pump and prevent the force main from draining back into the wet well.



*[Point out that references are listed on this page].*



We have now finished the first unit of this module. You should be familiar with the three types of pumping stations, the regulatory requirements associated with them and the important components of a pumping station.

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### UNIT 2: 50 minutes



Display Slide 11—Unit 2: Management and Operations of Pumping Stations.



At the end of this unit, you should be able to:

- List and explain three major policies and requirements associated with the management and operation of a collection system.
- List and explain the tasks, scheduling, record keeping and equipment maintenance requirements associated with the operation and maintenance of a wastewater collection system.

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POLICY AND REQUIREMENTS: 5 minutes



We will begin this unit with a brief overview of permitting requirements and annual reporting requirements as they relate to pumping stations.

### **Permitting**

*[Review the information in the workbook.]*

### **Annual Reporting – Chapter 94**

*[Review the information in the workbook.]*

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OPERATION AND MAINTENANCE: 45 minutes



The remainder of this unit will focus on the operation and maintenance of a pumping station. We will discuss the tasks, scheduling, recordkeeping and maintenance tasks required to operate and maintain the pumping station.

### Tasks



Let's begin by highlighting a few of the tasks required to operate the station.

#### Routine Maintenance

*[Review the information in the workbook.]*

#### Emergency Response

*[Review the information in the workbook.]*

#### Draw Down Tests

*[Review the information in the workbook.]*

### Scheduling



Now let's highlight some of the scheduling issues associated with the pumping station.

*[Review the information in the workbook.]*

### Recordkeeping



Next are the recordkeeping requirements, which are quite extensive. You will need to keep records that relate to personnel, equipment, sanitary sewer lines, service laterals, training, safety and accidents. Let's begin by looking at general recordkeeping information.

*[Review the information in the workbook.]*

### Personnel

*[Review the information in the workbook.]*

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### **Equipment**

*[Review the information in the workbook.]*

### **Sanitary Sewer Lines**

*[Review the information in the workbook.]*

### **Service Laterals**

*[Review the information in the workbook.]*

### **Training**

*[Review the information in the workbook.]*

### **Safety**

*[Review the information in the workbook.]*

### **Accidents**

*[Review the information in the workbook.]*

### Equipment Maintenance



In order to keep the pumping station running properly and efficiently, there are several maintenance tasks that need to be performed. We will discuss those in this last section of the unit.

#### Electrical

*[Review the information in the workbook.]*

#### Motors

*[Review the information in the workbook.]*

#### Pumps

*[Review the information in the workbook.]*

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### Compressors



Review the definition of compressors in the workbook.

*[Review the information in the workbook.]*

### Lubrication

*[Review the information in the workbook.]*



We have now completed this unit of the module. You should be able to explain the permitting and annual reporting requirements associated with pumping stations. You should also be able to identify the tasks, scheduling, recordkeeping and equipment maintenance requirements associated with the operation and maintenance of a pumping station.



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*[Review the Key Points for Unit 2 – Management and Operations of Pumping Stations.]*



## Exercise

1. Routine annual inspection of electrical equipment should include:
  - a. an examination
  - b. replacement of worn and expendable parts
  - c. operational checks and tests
  - d. **all of the above**
  
2. List 4 items that should be part of the records for a sanitary sewer line.
  - a. **answers may vary, see pages 2-4 and 2-5.** \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
  - d. \_\_\_\_\_
  
3. A permit is required to install and operate a pump station.
  - a. True
  - b. **False**
  
4. List 4 important maintenance procedures for compressors and indicate how often they should be done.
  - a. answers may vary, see page 2-7 \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
  - d. \_\_\_\_\_
  
5. Pump bearing failure may be preceded by cavitation sounds, unusual noises or vibration.
  - a. **True**
  - b. False

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### UNIT 3: 50 minutes



Display Slide 12—Unit 3: Safety.



At the end of this unit, you should be able to:

- Explain the safety procedures for traffic control, confined space entry, excavations and electrical systems.
- List and describe the major hazards associated with a collection system.

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**SAFETY PROCEDURES: 30 minutes**



We will begin this unit by discussing safety procedures that are of special concern to collection system operators. These safety procedures include traffic control, confined space entry for manholes, excavations and electrical hazards.

### **Traffic Control**



Collection system operators spend a great deal of time working in traffic in order to inspect, clean, rehabilitate and repair the collection system. Traffic control is necessary to reduce the risk of injury or death.

*[Review the information in the workbook.]*

### **Advance Warning Area**

*[Review the information in the workbook.]*

### **Transition Area**

*[Review the information in the workbook.]*

### **Buffer Space**

*[Review the information in the workbook.]*

### **Work Area**

*[Review the information in the workbook.]*

### **Termination Area**

*[Review the information in the workbook.]*

### Confined Space Entry – Manholes



Manholes are another safety concern for collection system operators. Working in manholes can be extremely hazardous and working in them requires that certain procedures be adhered to.



The most common cause of death in sewers is asphyxiation. Dangerous gases encountered in the wastewater industry include chlorine, methane, hydrogen sulfide and carbon monoxide. Hydrogen sulfide is especially present in sewers.

*[Review the information in the workbook.]*



Review the definition of confined space in the workbook.

*[Review the information in the workbook.]*

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*[Continue discussing Confined Space Entry – Manholes.]*



Figure 3.1 is a copy of a form that can be used confined space pre-entry checklist and a confined space entry permit. Some of the information found on the form include atmospheric checks and testing information, ventilation information and equipment information.

### Excavations



Excavations are another hazard that require adherence to some specific safety procedures. Let's review some of those now.

*[Review the information in the workbook].*



### Electrical



As a collection system operator, you may also be exposed to conditions that involve electrical equipment and hazards. You need to be knowledgeable about the potential for electrical hazards and be aware of procedures you should follow to help prevent or minimize these hazards.

*[Review the information in the workbook.]*

COLLECTION SYSTEM HAZARDS: 20 minutes

### **Accidents and Injuries**



In this section, we will discuss accidents and injuries that can occur when working in a manhole. Let's review some specific types of hazards you may encounter when working in a manhole.

#### **Atmospheric Hazards**

*[Review the information in the workbook].*

#### **Physical Injuries**

*[Review the information in the workbook].*

#### **Infection and Disease**

*[Review the information in the workbook.]*

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### **Insects and Biting Animals**

*[Review the information in the workbook.]*

### **Toxic Exposure**

*[Review the information in the workbook.]*

### **Drowning**

*[Review the information in the workbook.]*

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*[Go over the Key Points for Unit 3 – Safety.]*



### Exercise

1. Which of the following is not part of a traffic control zone?
  - a. A termination area.
  - b. An advance warning area.
  - c. **An emergency pull-off.**
  - d. A transition area.
  
2. Which of the following does not define a confined space?
  - a. It is large enough and so configured that a person can bodily enter it.
  - b. It is not designed for continuous occupancy.
  - c. **It does not provide sufficient natural light.**
  - d. It has limited or restricted means for entry.
  
3. Which of the following is a major hazard of entering a manhole?
  - a. Toxic exposure.
  - b. Physical injuries.
  - c. Psychological trauma.
  - d. Infection and disease.
  - e. **All of the above.**
  
4. No smoking is permitted inside or within 10 feet of a confined space.
  - a. **True**
  - b. False
  
5. Prior to beginning any excavation work, underground **utilities** need to be contacted and their respective lines located.
  
6. Work on electrical equipment should only be done by qualified and trained workers.
  - a. **True**
  - b. False
  
7. OSHA requires that a protective system be used in trenches **5** feet or deeper.

*[Point out that references are listed on this page.]*



We have now completed the entire training module. You should have an understanding of types of pumping stations and their components, the concepts regarding the management and operation of pumping stations and an understanding of the safety concerns and procedures associated with collection system operations. Are there any questions about the material we have covered in this module?