Wastewater Treatment Plant Operator Certification Training Instructor Guide

Module 23 Wastewater Collection Systems Part I

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 I,* is to provide an overview of collection systems, their design and construction and their management and operations. An understanding of the design and construction of collection system will assist you in operating and managing the system. 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
- Discussion Questions
- Unit Exercises
- Calculations

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

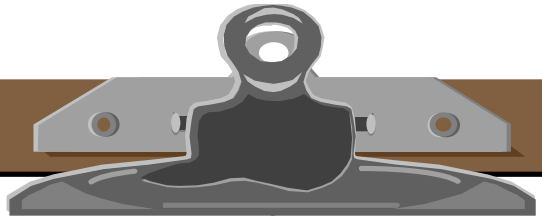
Icons to become familiar with include:

Participant Workbook	Instructor Guide
 Exercise/Activity	Same icons for Participant Workbook apply to the Instructor Guide.
 Case Study	Ans: 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.

To	**Press**
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

INTRODUCTION OF MODULE: 5 minutes

Display Slide 1—Module 23: Wastewater Collection Systems Part I.

[Welcome participants to "Module 23 – Water Collection Systems Part I." Indicate the primary purpose of this course is to provide an overview of collection systems, their design and construction, and their management and operations. An understanding of the design and construction of collection system will assist you in operating and managing the system.]

[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 Wastewater Collection Systems and Unit 2 – Design and Construction of Collection Systems.

[Briefly review outline.]

If you turn the page, you will see the topical outline for the remainder of Unit 2. You will also find the outline for Unit 3 – Management and Operations.

[Continue to briefly review outline.]

UNIT 1: 55 minutes

Display Slide 2—Unit 1: Overview of Wastewater Collection Systems.

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

- List and describe three types of collection systems.
- Compare and contrast sanitary and combined collection systems.

Display Slide 3—Unit 1: Overview of Wastewater Collection Systems.

The remaining two objectives for this unit are:

- Explain the appurtenances associated with wastewater collection systems.
- Describe the regulatory requirements associated with wastewater collection systems.

COMPONENTS: 40 minutes

We will begin with an overview of wastewater collection systems including types of collection systems, sanitary vs. combined systems, appurtenances and regulatory requirements. There are three types of collection systems: a gravity collection system, a low pressure collection system and a vacuum collection system. Let's begin by talking about the purpose of a collection system.

Types of Collection Systems

[Review the information in the workbook.]

Gravity

Let's begin with gravity collection systems. A gravity collection system moves water from residences, commercial and industrial facilities to a wastewater treatment plant.

[Review the information in the workbook.]

Low Pressure

The second type of collection system is the low pressure collection system.

[Review the information in the workbook.]

Display Slide 4—A Low Pressure Sewage System.

This slide shows a typical low pressure sewage system. As you can see, this system is around a lake. Each of the black dots you see represents a pressurization unit. This unit is connected to a service line, which is represented by the short solid line connected to the dot. Each service line is then connected to the pressure main, which surrounds the lake. Periodically located around the pressure main are valves and cleanouts, which are represented by small circles.

Vacuum

The third type of collection system is the vacuum collection system, which is an alternative to a gravity collection system.

[Review the information in the workbook.]

Display Slide 5—A Vacuum Collection System.

This slide shows a vacuum collection system. Looking at the top part of the graphic, you can see the vacuum sewer main along the right side. Perpendicular to this you will see the vacuum branch, and in the middle of the vacuum branch is the vacuum interface unit, which will transport the wastewater to the treatment plant located on the left side of the graphic. The bottom half of Figure 1.2 is a profile of the system.

Sanitary vs. Combined Systems

Now that we have covered the three types of collection systems, let's talk about sanitary and combined sewer systems.

[Review the information in the workbook.]

Appurtenances

Appurtenances are an important component of a collection system. We are going to spend the next several minutes discussing six types of appurtenances: manholes, backflow preventers, cleanouts, laterals, inverted siphons and flow regulators.

Review the definition of appurtenances in the workbook.

Manholes

Let's start with manholes.

[Review the information the workbook.]

Backflow Preventers

Backflow preventers are the second type of appurtenance.

[Review the information in the workbook.]

Display Slide 6—Backflow Preventers.

Backflow preventers must be accessible, and the type of preventer used is dependent on the ground elevation and building floor elevation. This slide shows two types of backflow preventers. The Type A preventer is used to stop accidental backflow or reverse flow of wastewater into buildings. This type is used when the elevation at the top of the device is lower than the floor elevation of the building plumbing system. It acts as a relief, so when the water elevation in the main sewer line and manholes reaches the same elevation as the bottom of the ball, the ball is lifted and raw wastewater flows out of the backflow preventer.

The Type B device uses a swing check valve or a ball check valve. As raw wastewater in the main line backs up, the check valve closes and prevents flow into the building plumbing system. A Type B preventer is used when ground elevation along the building sewer is above the floor elevation.

Cleanouts

Another type of appurtenance is a cleanout.

[Review the information in the workbook.]

Display Slide 7—Cleanouts.

This slide shows types and locations of cleanout in building sewers. There are two types of cleanouts: one for deep and one for shallow. The cleanout consists of a fitting with a pipe that is extended to grade. A cleanout is protected with a cleanout box to permit cleaning access.

Lateral

The next type of appurtenance is a lateral. Without consulting your workbook, can anyone tell me what a lateral is?

Ans: It is the piping that connects the public sewer to the building.

Inverted Siphon

The fifth type of lateral is the inverted siphon.

[Review the information in the workbook.]

Display Slide 8—An Inverted Siphon.

On this slide, you will see an example of an inverted siphon. As you can see, water enters through the inlet manhole, which is on the left side of this graphic, and passes through the pipe which flows under the watercourse. The velocity of the water pushes it up the pipe at the outlet manhole on the left side of the graphic.

Flow Regulators

The final type of appurtenance we will review is the flow regulator. Let's take a look at an example.

Display Slide 9—Flow Regulators.

In this slide you can see that weir plates are inserted in the manhole before each effluent line. These weir plates are located from the bottom to the bench of the manhole. This ensures that flow only enters the effluent line where the operator wants to direct the flow.

REGULATORY REQUIREMENTS: 15 minutes

Before a collection system is actually constructed, there are some regulatory requirements in regards to the planning of the system that must be fulfilled. Let's talk about the Sewage Facilities Act.

Sewage Facilities Act

[Review the information in the workbook.]

Appendix A in your workbook contains a copy of the *Planning Modules for Land Development* document. Let's take a quick look at this document. Please turn to Appendix A on page A-2. Please note the table of contents for the Appendices section on page A-1.

The first part of the appendix contains detailed instructions for completing the sewage facilities planning module application mailer.

The next document (beginning on A-9) is the "Exception to the Requirement to Revise the Official Plan." This component is used to satisfy the sewage facilities planning requirements for subdivisions of ten lots or less intended as building sites for detached single family dwellings served by individual on-lot sewage disposal systems.

The next component is the "Sewage Collection and Treatment Facilities" document (beginning on A-15). After this component you will see a copy of the "Municipal or Authority Sponsored Minor Sewage Collection Project" document (beginning on A-25).

The next component is for municipal planning agency review and is used for getting comments from planning agencies and/or health departments that have jurisdiction over the project area (beginning on A-33.

The final component of this appendix is for county planning agency review (beginning on A-36). It is also used to get comments from planning agencies and/or health departments that have jurisdiction over the project area.

[Review the Key Points for Unit 1 – Overview of Wastewater Collection Systems.]

Exercise for Unit 1 – Overview of Wastewater Collection Systems.

1. List three types of collection systems and explain how they each operate.

   a. Gravity – descriptions may vary.

   b. Low Pressure – descriptions may vary.

   c. Vacuum – descriptions may vary.

2. List six types of appurtenances used in collection systems.

   a. manholes

   b. **backflow preventers**

   c. cleanouts

   d. lateral

   e. inverted siphon

   f. flow regulators

3. A gravity sewer pipe or conduit is designed to carry wastewater flowing at 2 ft/sec.
   a. True
   b. False

4. Act **537** is commonly called the Sewage Facilities Planning Act.

5. Backflow preventers are used in a sanitary sewer lateral to prevent the accidental backflow of wastewater into buildings.
   a. True
   b. False

[Point out that references are included on this page.]

We have now concluded the first unit of this module. You should be able to explain the three types of collection systems and six different types of appurtenances found in a collection system. In the next unit, we will discuss the design and construction of a collection system.

[This page was intentionally left blank.]

UNIT 2: 85 minutes

Display Slide 10—Unit 2: Design and Construction.

[Wastewater collection system operators should have a basic knowledge of sewer system design. Many times they will be called upon to review plans and specifications.]

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

- List and explain three types of flows.
- Describe the regulatory requirements associated with the design and construction of a collection system.
- List and explain five factors that are important to the layout of a collection system.

Display Slide 11—Unit 2: Design and Construction.

The remaining three learning objectives for this unit are:

- List three factors that should be considered when installing a wastewater collection system and explain the importance of each.
- Identify and explain two important construction factors.
- Identify and explain two important construction testing factors.

FLOWS: 20 minutes

We will begin this module by talking about flows. Basically, a flow is defined as the continuous movement of a liquid from one place to another. We will discuss three types of flows: residential, commercial and industrial. Let's begin with residential flows.

Residential Land Use

[Review the first bullet item.]

Table 2.1 shows typical flow rates from various residential sources such as apartment buildings, individual residences and motels. All flows are listed in gallons per unit per day. For example, in a high-rise apartment, the typical flow is 50 gallons per person per day; while in a hotel, the typical flow is 45 gallons per hotel guest per day. In a motel, the typical flows are higher because they are based on each motel unit, rather than one person.

[Review the remaining information in the workbook.]

Commercial Land Use

Next we will talk about commercial flows.

[Review the information in the workbook.]

Table 2.2 shows typical flow rates from various commercial sources. Like Table 2.1 on the previous page, it lists flows in gallons per unit per day. Some of the examples of commercial sources are airports, bars, department stores, restaurants and shopping centers. In an airport, the typical flow is three gallons per passenger per day; while in a restaurant, the typical flow is also three, but it is three gallons per meal per day, not per person or per customer. As you can see, the higher flow rates are in department stores, which average 500 gallons per toilet room per day, and a self-service laundry, which has a typical flow of 550 gallons per machine per day.

Industrial Land Use

On this page, we have our final type of flow, which are industrial flows.

[Review the information in the workbook.]

Table 2.3 shows sewer capacity allowances, which are different than the previous two tables which showed typical flow rates. As you can see on this table, the information is listed for various cities and it is based on historical data. So, for example, in Santa Monica, CA, based on information from 1980, we can see that the industrial allowance was 13,600 gallons per day per acre.

Design Flow Calculation

When designing a collection system, it may be necessary to calculate design flows. Let's take a look at an example of how to calculate design flows.

[Review the information in the workbook.]

As you review each step in the calculation, write it on a flipchart.

REGULATORY STANDARDS: 10 minutes

We have finished our discussion about flows and will now turn our attention to the regulatory standards involved in the design and construction of a collection system. Let's review some of the standards that currently exist.

Standards

[Review the information in the workbook.]

Permitting

In addition to the construction design standards we just reviewed, there are some permitting requirements that must be fulfilled as well. Let's talk about those now.

[Review the information in the workbook.]

Appendix B (beginning on A-43) contains a copy of the Part II Permit Sewer Extensions and Pumping Stations. We will not review it in detail here; however, it has been provided for your reference.

LAYOUT: 5 minutes

In this section, we will discuss the layout of a collection system. A layout typically shows the location of lateral, mains and trunk sewers in the service area. It also shows the direction of flow in the system. The layout does not show the slope and size of the sewer lines because they are unknown at the time the layout is prepared. Since the layout does not indicate the slope and size, let's first talk about how to determine the slope and size.

Slope and Size

Review the definition of slope in the workbook.

[Review the information in the workbook.]

Location, Alignment and Depth

Now that the slope and size have been determined, the layout can begin. Let's talk about determining the location, alignment and depth of the laterals and the mains.

[Review the information in the workbook.]

Exercise for Unit 2 – Flows, Regulatory Standards, & Layout.

1. It is important to use a peaking factor for residential flow volumes to ensure that the collection system is large enough to convey the flow.
   a. **True** b. False

2. Flow estimates for commercial land use are generally based on **gallons** per **acre**. The actual values used depend on the type and size of the business occupying the land in question.

3. Determine the peak residential flow for a subdivision of 75 acres with homes on 1 acre lots and assume 3 people per home.
   (75 acres)(1 home/acre)(80 gal/person/day)(3 person/home) = 18,000 gpd

   Peak residential flow = 18,000 x 2.5 = 45,000 gpd

4. The minimum size of a new sanitary sewer shall be

   a. 6 inches b. **8 inches** c. 10 inches d. 12 inches

5. If a sanitary sewer must cross under a water main, there must be at least 18 inches of vertical clearance.
   a. True
   b. False

6. Which of the following statements are true?
   a. An Erosion and Sedimentation (E&S) control plan is needed for earth moving activity.
   b. Sanitary sewers should be 10 feet horizontally from existing or proposed water mains.
   c. The slope of a sanitary sewer is often called Rise/Run.
   d. **All of the above**.

7. The minimum depth of a sanitary sewer is **4** feet.

8. Sanitary sewers are often constructed to run in the middle of streets to provide easy access and manholes are typically placed about every **400** feet.

INSTALLATION: 15 minutes

Now that we know what the layout of the collection system is, we can begin installation. In this section, we will discuss three key installation issues: pipe strengths, pipe deflection and bedding.

Pipe Strengths

[Review the information in the workbook.]

Pipe Deflection

[Review the information in the workbook.]

Bedding

[Review the information in the workbook.]

Bedding Required for Rigid Pipe

The class of bedding used is design selection. The class chosen is based on the load factor that is required to ensure that the rigid pipe does not crack. In addition to the load factor, the cost and ease of placement should be considered when selecting a class of bedding.

Display Slide 12—Classes of Bedding.

This slide shows the different classes of bedding. Each class of bedding has a different load factor. The highest load of 3.4 is Class A with reinforced concrete and the lowest is 1.1 and would consist of placing the pipe on the trench bottom with no bedding. If the operator is installing a sewer or inspecting the installation of a rigid pipe, it is important to know what class of bedding was specified. It is also important to ensure that the proper type and amount of bedding is installed so that the pipe does not crack after it is installed and covered with backfill.

Bedding Calculation

Let's take a look at how to calculate the total supporting strength of a pipe.

[Review the information in the workbook.]

Bedding Required for Flexible Pipe

Now that we have finished learning about bedding required for rigid pipe, let's talk about bedding requirements for flexible pipe.

[Review the two bullet items in the workbook.]

Table 2.4 shows various soil classifications and their typical names. Class I soil is crushed rock. Class II soil is either well or poorly graded gravel or well or poorly graded sand. Class III soil is either silty or clayey gravel or silty or clayey sand. These three classes are the only ones allowed for bedding for flexible pipe.

[Review the remaining bullet item in the workbook.]

CONSTRUCTION INSPECTION: 15 minutes

We have finished our discussion about installation and will now talk about construction inspection.

Specifications

[Review the bullet item in the workbook.]

Figure 2.2 in your workbook shows an example of part of the contract drawings. This figure shows a typical sewer plan legend. The legend gives you an idea of the type of information you will see represented in specification and contract drawings. The drawings will show you what kind of structure and features will be part of the collection system and will indicate the location of things such as building, trees, valves, inlets, power lines and property lines.

On this page, you will see Figure 2.3, which is a drawing of a gravity sanitary sewer design. The purpose of this graphic is to give you an idea of what a contract drawing looks like.

Contract Drawings

Let's talk further about what is included in contract drawings.

[Review the information in the workbook.]

Specifications

Now let's talk further about specifications.

[Review the information in the workbook.]

[Review the remaining bullet items in the workbook.]

Records

As you can imagine, there is a great deal of recordkeeping tasks involved in the construction of a collection system. Let's talk about a few of those now.

[Review the information in the workbook.]

Figure 2.4 in your workbook shows you what an inspector's daily report might look like. This is used to keep track of the daily progress of the construction project. If you turn to the next page, you will see another type of report.

[Review the bullet item in the workbook.]

The report on page 2-18 is an example of a monthly report. As you can see, there is not as much information included on this report; however, the report is important since it is used to determine how much a contractor gets paid.

[Review the remaining information in the workbook.]

CONSTRUCTION TESTING: 20 minutes

During construction, it is necessary to test the system for leakage and deflection. Let's begin by talking about how we test for leakage.

Leakage

[Review the first two bullets in the workbook.]

Display Slide 13—Air Testing.

This slide shows how air testing is done. In this graphic, we see manhole to manhole air testing as well as air testing on a segment of pipe. Let's continue to look at this slide as we talk about how air testing works.

[Review the first bullet and related information in the workbook.]

Now that we have talked about air testing, let's talk about the second type of leakage testing, which is called water testing.

[Review the remaining information in the workbook.]

Calculation Rate of Exfiltration for Water Testing

As we just mentioned, the state of Pennsylvania has established acceptable levels of exfiltration. Let's take a look at how you can calculate the rate of exfiltration.

Review the calculation steps in the workbook by writing them out on a flipchart.

Be sure to emphasize the key point in the workbook.

Deflection

Now we will discuss our second type of construction testing, which is deflection. A deflected pipe is one which has been forced out of round by external pressures, or it is a pipe whose direction has been changed either to the left, right, up or down.

[Review the information in the workbook.]

Display Slide 14—Deflection Test Gage.

This figure is an example of a deflection test gage. The bottom half of the figure shows the test gage, or mandrel, being pulled through the pipeline. The top portion of the figure shows you a magnified view of the test gage itself. As you can see, there are rings at each end of the gage. The lines that are used to pull the mandrel through the pipeline are attached to these rings. The ends of the gage are tapered with a diameter equal to 95 percent of the average diameter of the pipe to be tested.

[Review the Key Points for Unit 2 – Design and Construction of Collection Systems.]

Exercise for Unit 2 – Installation, Construction Inspection & Testing.

1. The two major types of pipes used in collection systems today are **rigid** pipe and **flexible** pipe.

2. Pipe **deflection** is when the pipe has changed direction, either up, down, right or left from the direction it was originally laid.

3. When using rigid pipe, which class of bedding is typically not permissible?

   a. Class A b. Class B c. Class C d. **Class D**

4. An 8-inch diameter Vitrified Clay Pipe (VCP) has a standard strength of 2,000 pounds per foot, and is laid in a Class B trench. What is the total supporting strength?

   (2000 lb/ft)x(1.9) = 3800 lb/ft

5. The contract drawings provide a **graphical** representation of the work to be done.

6. The qualitative requirements for a project covering topics like the material and workmanship involved in the manufacturing and installation of equipment can be found in the:

   a. Legend b. Index c. **Specifications** d. PA One Call

7. Name the two types of reports that an inspector would normally write to keep track of progress and problems at a work site.

   a. **Daily reports** b. **monthly reports**

8. Liquid leaking out of a collection pipe is called **exfiltration** .

9. Liquid leaking into a collection pipe from the surrounding bedding material is called **infiltration** .

10. A deflection test gage ball or mandrel can not be pulled through a sewer pipe if the pipe is deflected more than five percent of the pipe diameter.

    a. True
    b. False

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

We have completed the second unit of this training module. You should now be familiar with flows and the regulatory standards associated with construction of a collection system. You should also understand what is involved in the layout of a collection system as well as what needs to be considered when installing and constructing the system. In the next unit, we will learn about the management and operation of a collection system.

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UNIT 3: 130 minutes

Display Slide 15—Unit 3: Management and Operations.

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

- List and describe the policies and requirements associated with the management and operations of a collection system.
- List and explain three cleaning methods and five inspection methods.
- Define infiltration and inflow and explain how to determine their sources.

Display Slide 16—Unit 3: Management and Operations.

The remaining three learning objectives for this unit are:

- List and explain three rehabilitation methods.
- Describe how manholes and appurtenances are rehabilitated.

POLICIES AND REQUIREMENTS: 15 minutes

We will begin this module by talking about policies and requirements related to the operation and maintenance of a collection system. Let's start with permit requirements.

Permit Requirements

[Review the information in the workbook.]

Annual Reporting – Chapter 94

Now let's turn our attention to Chapter 94 requirements.

[Review the information in the workbook.]

Capacity, Maintenance, Operations and Management (CMOM)

The last area of policy we will review address combined sewer overflows and long-term control plans.

Combined Sewer Overflows Policy

[Review the information in the workbook.]

Long Term Control Plan

[Review the information in the workbook.]

CLEANING AND INSPECTION: 50 minutes

A major part of operating a collection system is cleaning and inspecting it to ensure efficient operation. First, we will review three cleaning methods: mechanical, hydraulic and chemical cleaning. After that we will discuss inspection methods.

Cleaning Methods

Mechanical

There are three types of mechanical cleaning methods we will learn about: power bucket cleaning, power rodding and hand rod cleaning.

[Review the information in the workbook.]

Display Slide 17—Power Bucket Cleaning.

This slide demonstrates the power bucket operation. As we just mentioned, there are two machines used. You can see them on each side of the illustration at the top of the manhole. The "bucket" device is located in the pipe at the bottom of the illustration, and a magnified view of the bucket is shown in the middle of the illustration.

The power rodder is the next type of mechanical cleaning method.

[Review the information in the workbook.]

Display Slide 18—Power Rodder.

This slide illustrates a typical set up for a power rodder. In this picture, you can see the steel rod located in the pipe at the bottom of the picture. Attached to the rod is a root saw and coupler, which are used to remove the stoppage. Now let's talk briefly about hand rods.

[Review the bullet item in the workbook.]

Hydraulic

Now let's talk about the second type of cleaning, which is hydraulic cleaning. We will highlight five hydraulic cleaning methods: balling, high-velocity cleaning, flushing, sewer scooters, and the use of kites, bags and poly pigs. Let's talk about balling.

[Review bullet information in the workbook.]

Display Slide 19—Cleaning with a Sewer Ball.

Figure 3.3 shows the balling method in action. If you look closely at the ball, you will see the diagonal grooves that the water will flow through. Behind the ball, you can see the water that is pushing it through the sewer line.

Display Slide 20—Setup for Hydraulic Cleaning.

This slide is another example of the use of a ball for cleaning a sewer line. This setup uses the existing water flow to push the ball. You can also see that the ball is attached to a power bucket, which is above ground.

Now let's find out about high velocity cleaning, another hydraulic cleaning method.

[Review the information in the workbook.]

Display Slide 21—High Velocity Cleaner.

This slide illustrates the high-velocity cleaner set-up. In this illustration, the equipment is truck-mounted. The high pressure hose is located in the pipe at the bottom of the illustration, and you can see that high pressure water is coming from the nozzle of the hose.

The next hydraulic cleaning method is flushing.

[Review the information in the workbook.]

Display Slide 22—Flushing Operation.

For a flushing operation, you can use the tanker, the fire hydrant or both. In this illustration, you will see that both are being used. Although flushing is useful for removing floatable solids, it is not as effective as balling or high velocity cleaning because the water does not generate a velocity sufficient enough to move heavier debris.

Next we will talk about sewer scooters.

[Review the information in the workbook.]

Display Slide 23—Sewer Scooter.

Like some of the other cleaning methods we have discussed, the sewer scooter uses water pressure to clean. This slide shows how the sewer scooter is set-up. The scooter can remove debris such as rock, brick or gravel.

The final method of hydraulic cleaning we will discuss the use of kites, bags and poly pigs.

[Review the information in the workbook.]

Display Slide 24—Poly Pig.

The top portion of this slide shows how the poly pig travels through the force main, while the bottom portion of the slide shows different types of poly pigs that can be used. Different pigs can be used depending on the degree of cleaning you need to do.

Chemical

Our final type of cleaning is chemical cleaning. Let's spend a few minutes talking about it.

[Review the information in the workbook.]

Inspection

Now that we have finished learning about various cleaning methods, let's spend some time talking about inspection techniques. We will review five inspection techniques: closed circuit television, smoke testing, dye testing, lamping and manholes.

[Review the information in the workbook.]

Closed Circuit Television (CCTV)

Closed circuit television, or CCTV, is our first inspection technique.

[Review the information in the workbook.]

Display Slide 25—CCTV.

This slide shows how a CCTV would be set up. The use of CCTV gives reliable information about the condition of the pipeline because it eliminates a lot of guesswork.

Smoke Testing

The next inspection method is smoke testing.

[Review the information in the workbook.]

Display Slide 26—Smoke Testing.

This slide shows a smoke testing setup. The plugs are used to isolate two sections of pipe between three adjacent manholes. The blower sits over a manhole and forces a blast of air into the manhole. This establishes the air flow. Then the smoke bombs are lit and lowered into the manhole, and the results of the smoke test are observed and documented. If you look at page 3-16, you will see an example of a smoke test report.

[Point out that this is a sample of a smoke test report.]

Dye Testing

The third inspection method is dye testing.

[Review the information in the workbook.]

Lamping

Lamping is the next inspection technique.

[Review the information in the workbook.]

Manholes

The last inspection topic we will discuss is manhole inspection.

[Review the information in the workbook.]

On this page, you will find a copy of a completed manhole inspection report. Any defects found during the inspection are recorded on this form.

INFILTRATION AND INFLOW: 20 minutes

We have completed our discussion of cleaning and inspection methods and will now move on to the topic of infiltration and inflow. Let's start by making sure we understand what infiltration and inflow are.

Definitions

Review the defintions.

[Review the bullet item in the workbook.]

Sources

Infiltration and inflow can come from several different sources.

What are some of the typical sources of infiltration?

Ans: Typical sources of infiltration are cracks in pipes, leaks around pipe joints, leaks at the connection of the lateral to the sewer and leaks in the manhole walls.

What are some of the typical sources of inflow?

Ans: Sources of inflow include cross connections from storm sewers, illegal connections from private residences including roof leaders, sump pumps, yard area drains and foundation drains, cooling water discharges from industry and drains from springs.

Investigations

Now that we know what infiltration and inflow are and what their sources are, let's talk about how to determine their sources.

[Review information.]

Inspections

There are three types of inspections used to determine the source of infiltration and inflow.

Visual Inspection

[Review the information in the workbook.]

Smoke Testing

[Review the information in the workbook.]

Building Inspections

[Review the information in the workbook.]

REHABILITATION: 45 minutes

Our final topic in this unit is rehabilitation. We will begin with a discussion of how to evaluate system problems and then we will discuss different rehabilitation methods. We will also review specific issues about rehabilitating manholes and appurtenances.

System Evaluation and Problems

[Review the information in the workbook.]

Flow Metering and Analysis

[Review the information in the workbook.]

Condition Assessment

In addition to determining the amount of infiltration and inflow in the system, it is necessary to determine the condition of the system.

[Review the information in the workbook.]

Prioritizing Rehabilitation

After determining the condition of the system, it will be necessary to prioritize the work to be done.

[Review the information in the workbook.]

Rehabilitation Methods

Now let's talk about different rehabilitation methods.

[Review the information in the workbook.]

Excavate/Replace

The first rehabilitation method is to excavate or replace.

[Review the information in the workbook.]

Chemical Grouting

The second rehabilitation option is chemical grouting.

[Review the information in the workbook.]

Trenchless Technology

The third rehabilitation method is trenchless technology. There are several types of trenchless technology we will highlight: sliplining, cured-in-place, deformed and reshaped and pipe bursting.

[Review the information in the workbook.]

Sliplining

[Review the information in the workbook.]

Display Slide 27—Sliplining.

This slide shows how sliplining works. If you look at the bottom of the illustration, you can see the existing sewer pipe with a new pipe being inserted into it. Sliplining can be used if the existing pipe and its dimensions are in relatively good shape.

Cured-in-Place

The next type of rehabilitation is cured-in-place. This method is used to rehabilitate gravity sewers and force mains.

[Review the first bullet item in the workbook.]

Display Slide 28—Cured-in-Place.

Let's take a look at this illustration of the sliplining method as we discuss how it works.

[Review the remaining two bullet items in the workbook.] .

Deformed and Reshaped

The third rehabilitation method is called deformed and reshaped.

[Review the information in the workbook.]

Pipe Bursting

Our final rehabilitation method is known as pipe bursting.

[Review the information in the workbook.]

Display Slide 97—Pipe Bursting.

This slide shows how the pipe bursting method works. The black pipe represents the new pipe. The dotted area at the bottom of the picture indicates the existing pipe that is being broken. To the right you can see a white bullet shaped object, which is the burster that actually breaks the existing pipe.

Rehabilitation of Manholes

Now that we have finished discussing various rehabilitation methods used for collection systems, let's talk about some methods used to rehabilitate manholes. We will talk about grouting, coating and lining.

[Review the information in the workbook.]

Grouting

[Review the information in the workbook.]

Coating

[Review the information in the workbook.]

Lining

[Review the information in the workbook.]

Rehabilitation of Appurtenances

Our last rehabilitation topic is the rehabilitation of appurtenances.

[Review the information in the workbook.]

[Review the Key Points for Unit 3 – Management and Operations.]

Exercise

1. List the three types of collection system cleaning methods.

   a. chemical

   b. hydraulic

   c. mechanical

2. What are the three methods of mechanical cleaning?

   a. power buckets

   b. power rodders

   c. hand rods

3. List three of the six types of hydraulic cleaning and explain when each method is appropriate for use.

   a. balling – grit and grease removal

   b. high velocity cleaners – loose debris removal

   c. flushing – floatable solids removal or sewer scooter, kites, bags, and poly pigs.

4. List three rehabilitation methods.

   a. excavate and replace

   b. chemical grouting

   c. sliplining, or cured-in-place, deformed and re-shaped, and pipe bursting

5. Smoke testing can be useful in detecting:
   a. illegal sump pump connections b. cracks in sewer piping
   c. storm sewers connected to sanitary sewers d. all of the above

6. Lamping can be used to determine if a sewer is not straight or blocked.
   a. True b. False

7. Grouting is an excellent way to repair the structural integrity of a deteriorated manhole.
   a. True b. False

[Point out that references are listed on this page, and the Appendices section follows.]

We have now completed this module. At this point, you should be familiar with the various types of collection systems and appurtenances as well as regulatory requirements for the construction of a collection system. You should also have an understanding of what is involved in the design and construction of a collection system as well at its maintenance and operation. Are there any questions about the material we have covered?