November 3, 2023

Collection System **Maintenance**

Presented by:

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Town of Erie

Words

- SSO- Sanitary Sewer Overflow
- CSO – Combined Sewer Overflow
- Exfiltration – WW unintentionally leaks out of system
- I&I – Infiltration/Inflow
- NPDES Permit – Permit issued by state for discharging to WOTUS
- WOTUS – Waters of the US
- SCADA – Supervisory Control & Data Acquisition
- Sanitary Sewer Pipe – Conduit to carry wastewater from home/businesses/industries to treatment plant
- Surcharge – Flow becomes more than the capacity the pipes were designed to carry.

Words Continued…

- EPA – Environmental Protection Agency
- CMOM- Capacity, Management, Operations, Maintenance
- NPDES – National Pollutant Discharge Elimination System
- CIPP – Cured in Place Pipe
- FOG – Fats, Oils, and Grease.
- GIS – Geographic Information System
- H2S – Hydrogen Sulfide Gas (smells like rotten eggs, produced under anaerobic conditions.)
- Anaerobic – A condition in which atmospheric or dissolved oxygen (DO) is not present in the water environment.
- Aerobic – A condition in which atmospheric or dissolved oxygen is present in the water environment.

What is a Wastewater Collection System?

A wastewater collection system gathers the used water from homes and businesses and conveys it to a waste water plant.

The collection system includes the following?

- Gravity sewers
- Force Mains
- Manholes
- Pumps
- And other facilities that collect and convey the wastewater to a treatment plant

Why is maintenance of a collection system important?

Proper maintenance of a collection system provides for the safe and efficient conveyance of wastewater to the treatment plant and the mitigation of gases and odors.

Effective collection system operations and maintenance provides several benefits to a waste water agency and the public:

- Avoids or minimizes public health and environmental impacts
- Reduces backups and Sanitary Sewer Overflows (SSOs)
- Reduces odors in communities
- Minimizes backup claims
- Optimizes resources and reduces overall Operation & Maintenance costs
- Increases the service life of the facilities
- Minimizes potential exposure to enforcement and third-party lawsuits
- Enhances the image of the wastewater agency
- Maximizes the available system hydraulic capacity.

Safety

Before starting any work its always good to understand the potential hazards you may need to face. A trained professional operator demonstrates an awareness of hazards and a commitment to accomplish a task in a safe manner.

Some examples are:

- Vehicle Operation
- Working in streets (Traffic Control)
- Confined Space Hazards
- Safety Equipment for a Confined Space
- Manhole Entry Procedures
- Excavation and Shoring
- Electricity
- Firefighting
- Hazard Communication Standard (HCS) and worker Right-to-Know (RTK) Laws.

General Knowledge – Gravity Sewers

- Slope follows the lay of the land where possible
- Designed for 2 to 8 ft/sec flow, 2.5 ft/sec is ideal
- Should maintain a minimum velocity of 2 ft/sec at average peak flows.
- Should be designed for a maximum expected flow when max population density has been developed.

General Knowledge pipe selection

- Resistance to deterioration
- Ability to withstand surface loads
- Resistance to root intrusion
- Ability to minimize leakage
- Cost
- Service Life Span

Some Examples of Pipe Materials

- Asbestos Cement - AC
- Reinforced or Non-reinforced Concrete Pipe
- Vitrified Clay
- High Density Polyethylene – HDPE
- Polyvinylchloride - PVC

Need for Collection System Operators

The need for well-trained wastewater collection operators should not be underestimated. Operators assume the formidable responsibility of protecting public health and safety, the environment, controlling O&M expenses, and preserving the community's capital investment.

Operators must possess a range of knowledge and skills which include.

- Safety
- Electrical
- Mechanical
- Hydraulics
- Construction
- Design

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COLORADO Department of Public Health & Environment

Types of Collection System Problems

- Design
- Improper installation
- Inadequate sewer ordinances – Poor communications between dischargers to sewers and enforcers of ordinances.
- Improper inspection and enforcement of taps or service connections made by individuals.
- Changing patterns of activities and populations shifts.
- Natural disasters
- Problems of recurrent nature such as accumulations of grease, debris, and trash resulting in SSO's.
- Region Characteristics – Climate, high sulfate content in water, high soil or wastewater temps, rapid root growth, and mucky soils.
- Poor coordination between local agencies.
- Old and neglected collection systems.

Cleaning and Maintenance

- Hydraulic Cleaning
- Preventative Maintenance
- Rodding
- Stoppages

Methods for Cleaning and Maintaining Sewers

Sewer cleaning and maintenance methods used depend on several characteristics.

- Fluctuations in Flows
- Alignment or grade of the pipe
- Physical Condition
- Accessibility
- Diameter or configuration
- Pipe material
- Location
- Records – has this been cleaned before?

Once you understand the characteristics of the system you'll be able to use the proper methods for cleaning and maintaining the sewer system.

Equipment to Maintain the Collection System

Operators must be familiar with and know how to use a wide range of different types of equipment such as:

- High-Velocity Cleaning machines
- Rodders
- Vacuum Equipment
- Generators
- Pumps
- Bucket Machines
- Pickup / Dump Trucks
- Backhoe
- Compressors
- CCTV Equipment

Hydraulic Cleaning Methods

Hydraulic cleaning methods consist of cleaning a sewer with water under pressure that produces high water velocities. The velocities are usually high enough to wash out most grit, grease, and debris found in sewers.

Cleansing velocities can be obtained by allowing water pressure or head to build up in the line or by using a pump to produce the water pressure.

Hydraulic Cleaning equipment most commonly used includes High-Velocity Cleaners (HVC's), kites, bags, poly pigs, and scooters.

High-Velocity Cleaners (HVC's)

Most effective Method for emergency stoppages;

- *High-Velocity Cleaning – HVC's*
- *Power Rodders*
- *Hand Rodders*

https://youtu.be/8svLITMs0L8

- Hydro-Jet
- Combination Jet

With HVC's, a flushing nozzle is installed on the end of a hose, the hose is then lowered into the downstream manhole of the section being cleaned and uses the high-pressure to propel the flushing nozzle and hose upstream.

As the nozzle moves up and down the pipe, it will dislodge sediment, roots and other debris and wash it downstream to be removed.

Nozzle Types

Understanding nozzles and how they work is a key step to cleaning a line successfully and efficiently. Knowing the proper use of each nozzle ensures that you always select the right one for the job.

- Penetrators
- Combination Jet
- Rotational or Spinning Nozzles
- Root Saws
- Bottom or Floor Cleaners
- Breaks Blockages
- Multi-angled Jets for cleaning Debris
- Radius cleaning or removing light grease.
- Heavy Roots
- Heavy Settled Solids

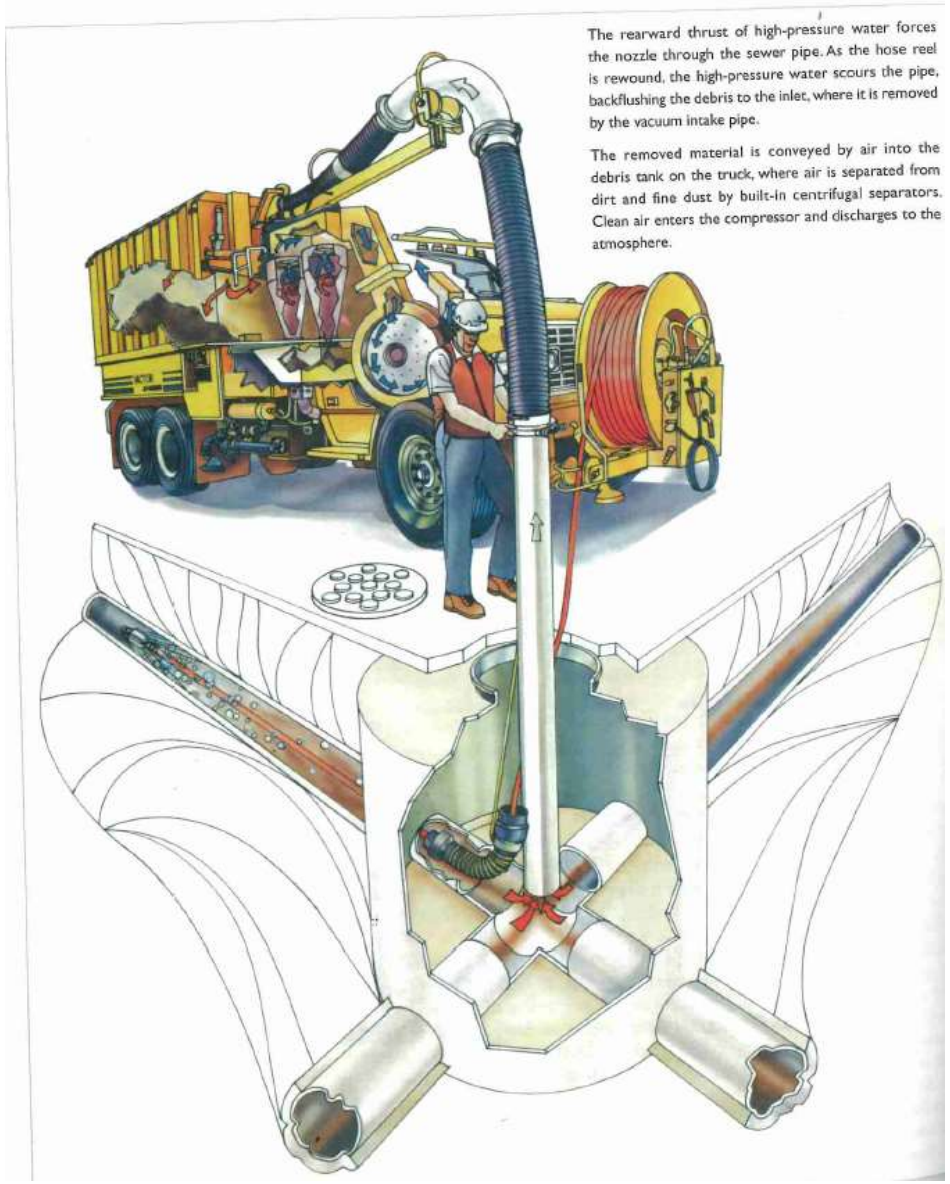
Nozzle Categories

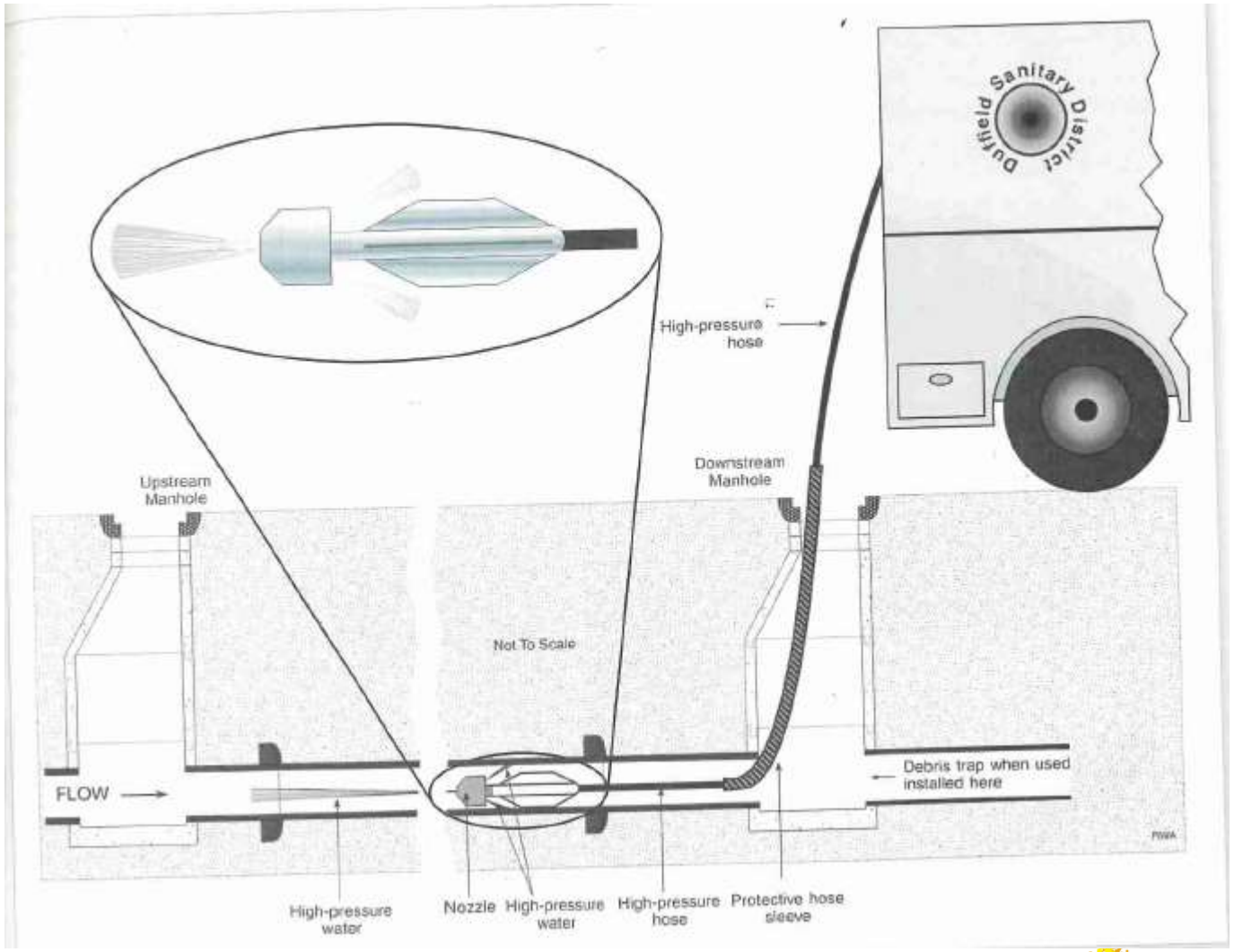
Nozzles are broken down into three tiers based on efficiency for moving water.

- Tier 1 Nozzles
  - Have orifices drilled out in different locations and sizes and at different angles, which can mean inefficient flow dynamics and less performance. When the water enters the nozzle, it hits into the back of its interior, then bounces out in the opposite direction while exiting through the drilled holes. During this process, a considerable amount of energy is lost. These nozzles are relatively inexpensive and don't last as long. Over time, the drilled jet holes wear out and the nozzle becomes ineffective.
- Tier 2 Nozzles
  - Have better flow dynamics than Tier 1 nozzles. They have replaceable inserts that also straighten the jet streams as they exit the nozzle. When the jet orifices wear out, these nozzles can be restored to their full operating capacity by replacing the inserts.
- Tier 3 Nozzles
  - Are designed to maximize the efficiency of water flow. Flow dynamics are designed to significantly increase the water pressure exiting the jets. Under certain conditions, these nozzles can increase cleaning efficiency. Their only downside is the fact that they can be very costly. However, the cost is usually offset by increased efficiency.

The rearward thrust of high-pressure water forces the nozzle through the sewer pipe. As the hose reel is rewound, the high-pressure water scours the pipe, backflushing the debris to the inlet, where it is removed by the vacuum intake pipe.

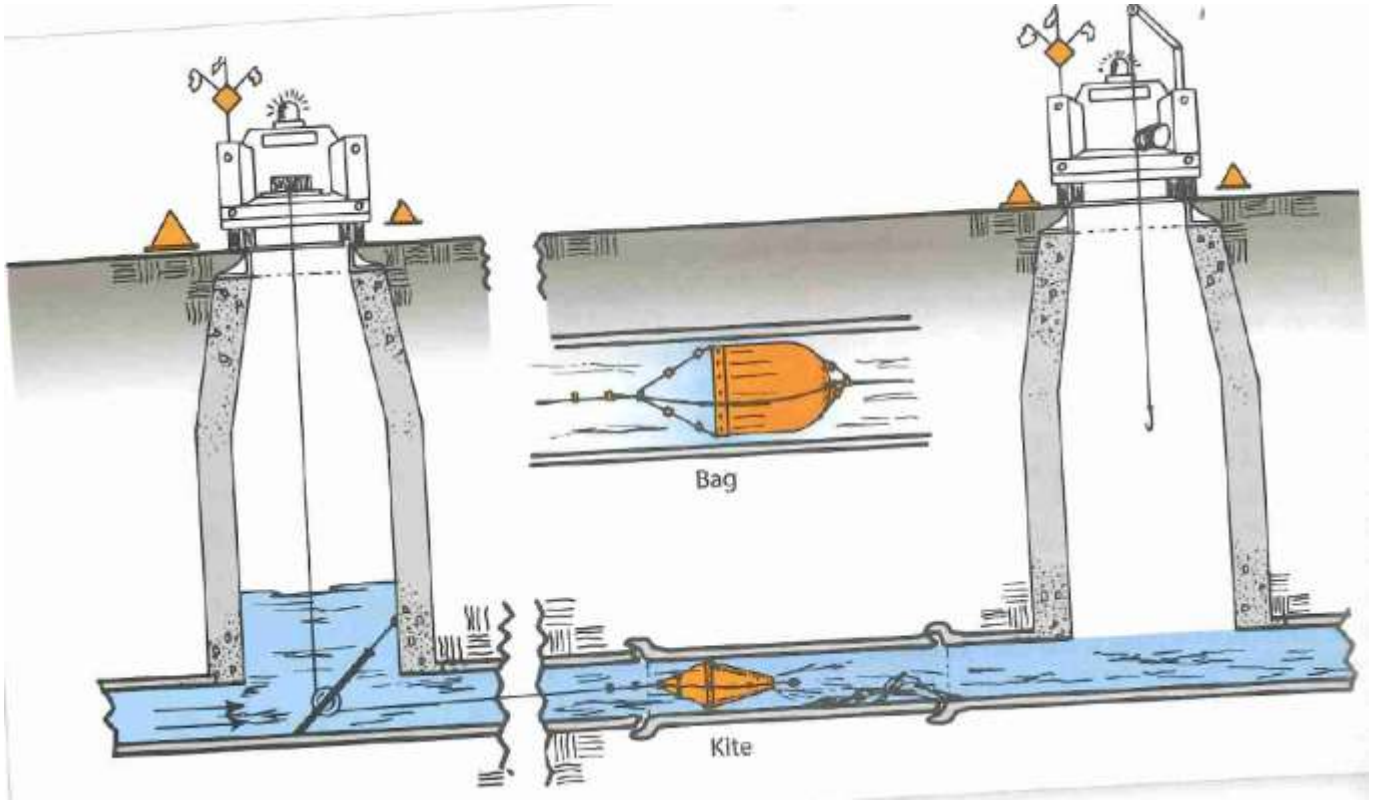
The removed material is conveyed by air into the debris tank on the truck, where air is separated from dirt and fine dust by built-in centrifugal separators. Clean air enters the compressor and discharges to the atmosphere.





Kites, Bags, and Poly Pigs

Force Mains and some other large-diameter sewers require the use of cleaning techniques other than the High-Velocity Cleaner. Kites, Bags, and Poly Pigs can clean force mains more effectively.

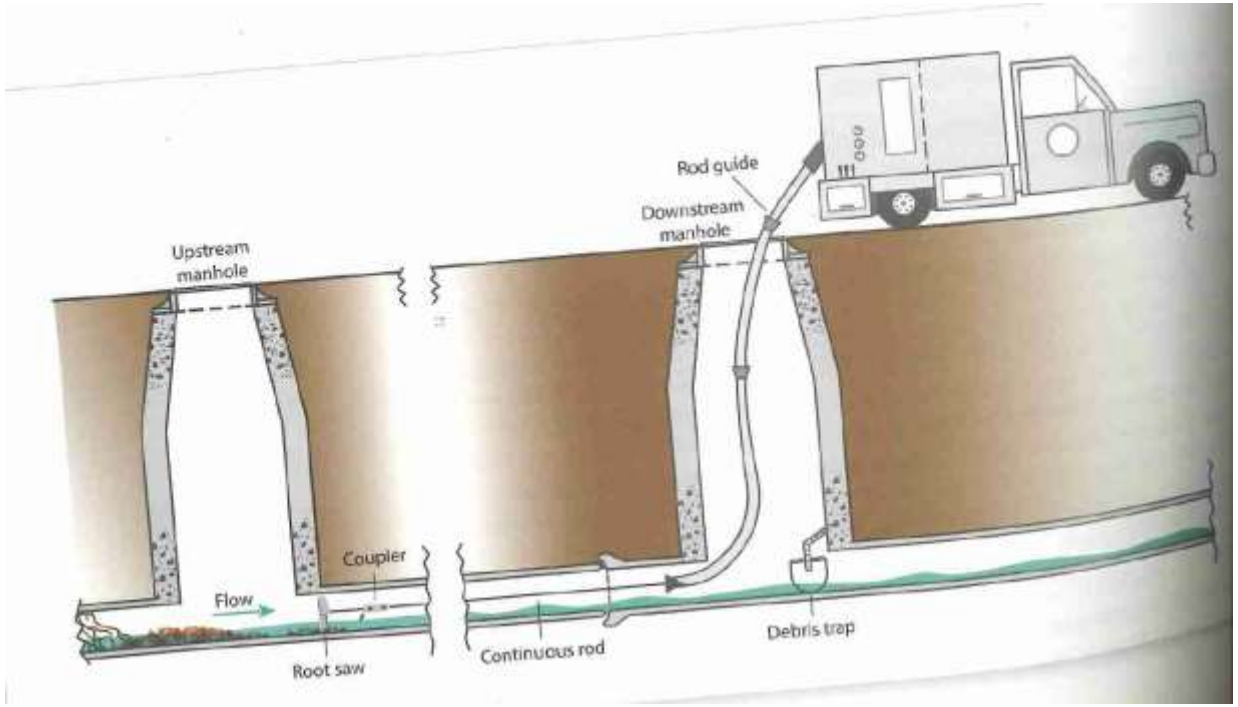


Power Rodders

Introduced in the 1950's Power rodding machines use a steel rod to push or pull various clearing tools through sewers. There are multiple designs of these and are usually equipped to store either continuous or sectional rod in a reel-type cage in lengths up to approximately 1,000 feet. The reel can be rotated to give turning action as the rod is pushed in or removed.

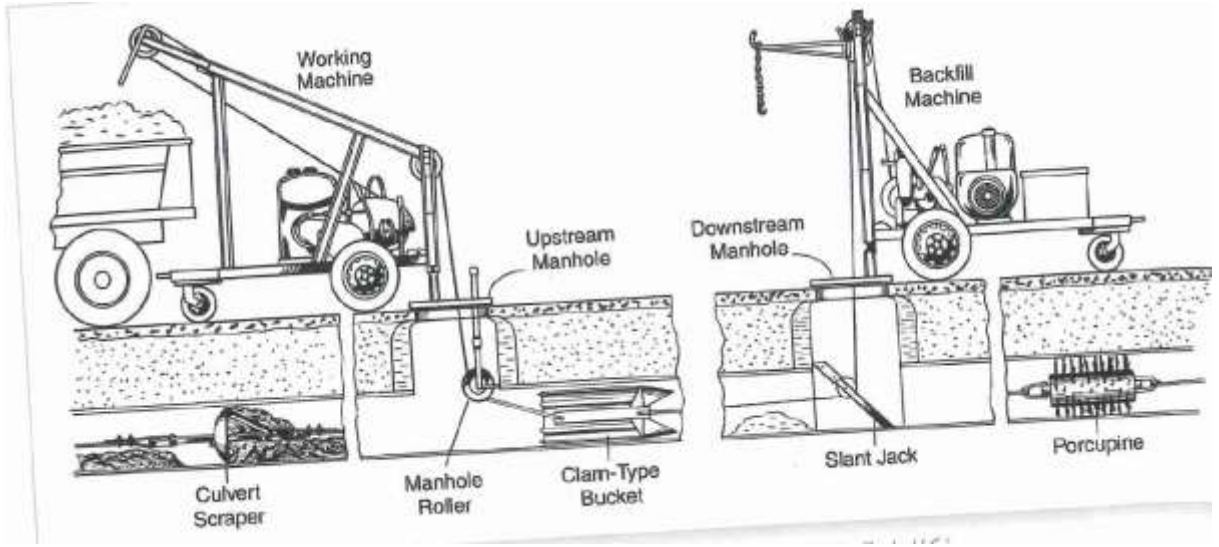
Power Rodders can be used for:

- Routine Maintenance
- Scheduled clearing of debris in flat lines.
- Threading cable for CCTV and bucket machines.
- Emergency use for stoppages.

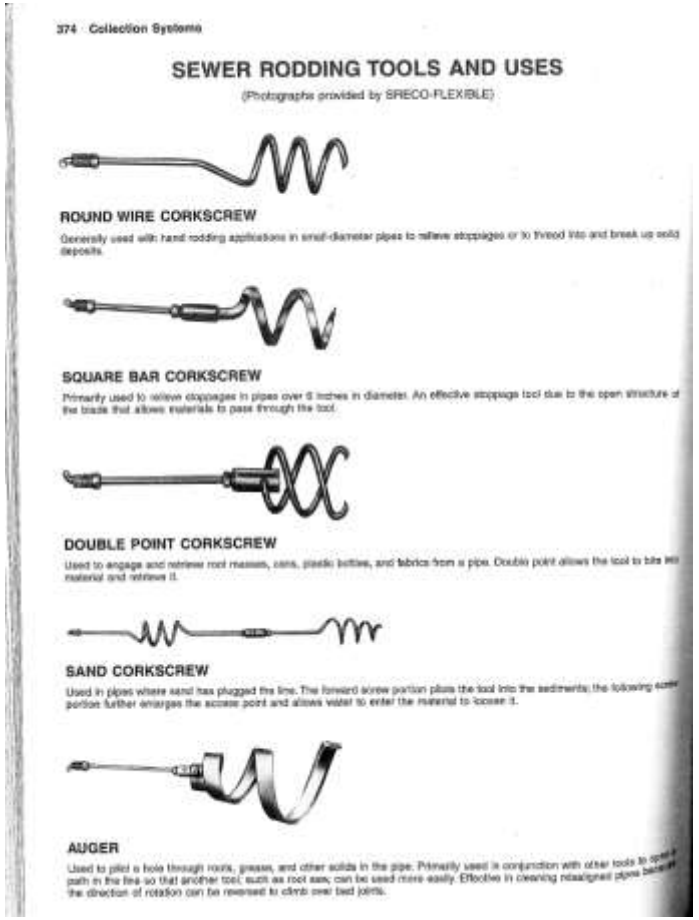


Other methods of Cleaning

- Hand Rodder
  - Oldest style of cleaning
  - Usually Spring, coil or detachable rods
  - Typically limited to 100 feet.
  - Used where sewer access is limited.
- Bucket Machine.
  - For larger lines over 12 inches.
  - Removes Heavy debris/mud.



Other Rodding Tools and Uses



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SEWER RODDING TOOLS AND USES

(Photographs provided by SRECO-FLEXIBLE)

ROUND WIRE CORKSCREW

Generally used with hand rodding applications in small-diameter pipes to relieve stoppages or to thread into and break up solid deposits.

SQUARE BAR CORKSCREW

Primarily used to relieve stoppages in pipes over 6 inches in diameter. An effective stoppage tool due to the open structure of the blade that allows materials to pass through the tool.

DOUBLE POINT CORKSCREW

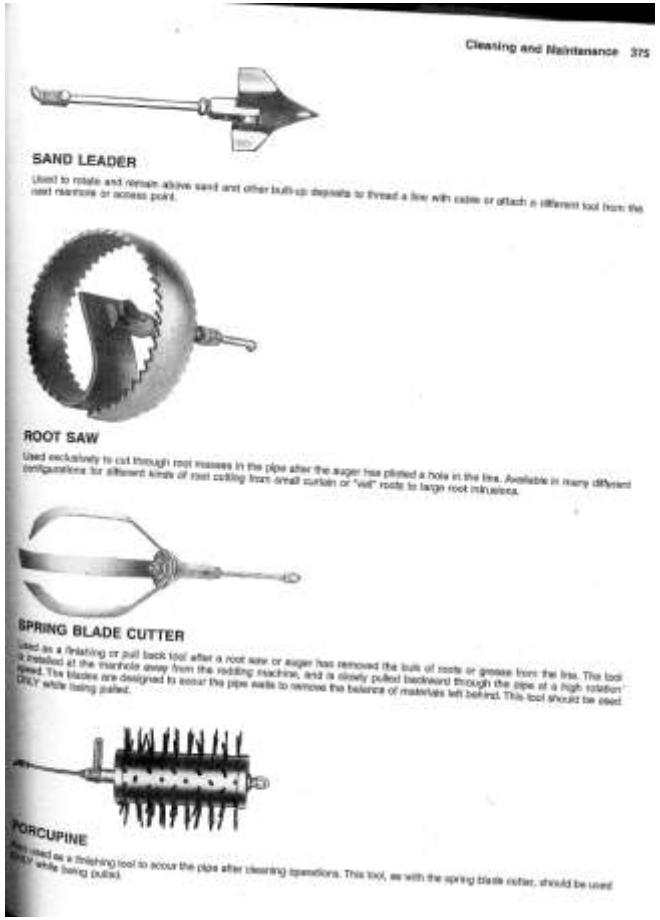
Used to engage and retrieve root masses, cans, plastic bottles, and fabrics from a pipe. Double point allows the tool to bite into material and retrieve it.

SAND CORKSCREW

Used in pipes where sand has plugged the line. The forward screw portion plows the tool into the sediments; the following screw portion further enlarges the access point and allows water to enter the material to loosen it.

AUGER

Used to pilot a hole through rocks, grease, and other solids in the pipe. Primarily used in conjunction with other tools to open a path in the line so that another tool, such as root saw, can be used more easily. Effective in clearing misaligned pipes because the direction of rotation can be reversed to climb over bad joints.



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SAND LEADER

Used to rotate and remain above sand and other built-up deposits to thread a line with cable or attach a different tool from the used rearmore or access point.

ROOT SAW

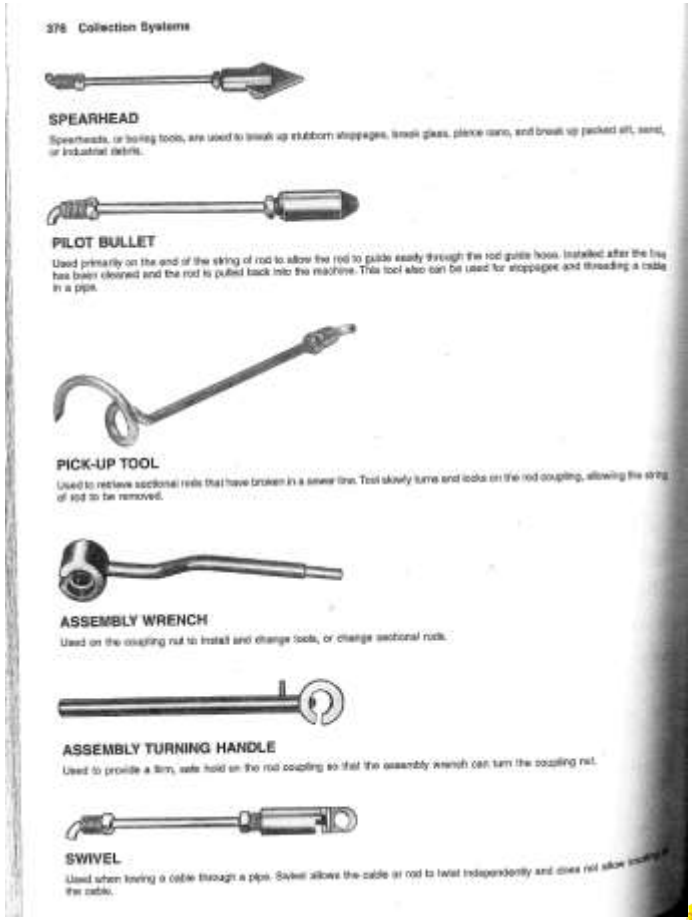
Used exclusively to cut through root masses in the pipe after the auger has pilotted a hole in the line. Available in many different configurations for different kinds of root cutting from small curtain or "veil" roots to large root intrusions.

SPRING BLADE CUTTER

Used as a finishing or pull back tool after a root saw or auger has removed the bulk of roots or grease from the line. The tool is installed at the manhole away from the rodding machine, and is slowly pulled backward through the pipe at a high rotation speed. The blades are designed to scour the pipe walls to remove the balance of materials left behind. This tool should be used ONLY while being pulled.

PORCUPINE

Also used as a finishing tool to scour the pipe after cleaning operations. This tool, as with the spring blade cutter, should be used ONLY while being pulled.



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SPEARHEAD

Spearheads, or boring tools, are used to break up stubborn stoppages, break glass, pierce cans, and break up packed silt, sand, or industrial debris.

PILOT BULLET

Used primarily on the end of the string of rod to allow the rod to guide easily through the rod guide hose. Installed after the line has been cleaned and the rod is pulled back into the machine. This tool also can be used for stoppages and threading a cable in a pipe.

PICK-UP TOOL

Used to retrieve sectional rods that have broken in a sewer line. Tool slowly turns and locks on the rod coupling, allowing the string of rod to be removed.

ASSEMBLY WRENCH

Used on the coupling nut to install and change tools, or change sectional rods.

ASSEMBLY TURNING HANDLE

Used to provide a firm, safe hold on the rod coupling so that the assembly wrench can turn the coupling nut.

SWIVEL

Used when leving a cable through a pipe. Swivel allows the cable or rod to twist independently and does not allow kinking in the cable.

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Chemicals

Chemicals can be helpful in cleaning and maintaining collection systems. If applied properly chemicals can be used to control roots, grease, rodents, insects, odors and corrosion.

Make sure chemicals are approved by the EPA and your organization.

Live Roots

Dead Roots

Atmospheric Hazards

OSHA defines a hazardous atmosphere as an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue, injury, or acute illness from one or more of the following causes:

- Flammable gas, vapor, or mist in excess of 10 percent of its lower explosive limit (LEL).
- Airborne combustible dust at a concentration that meets or exceeds its LEL
- Atmospheric **oxygen** concentration below **19.5 percent or above 23.5 percent**. Normal oxygen content should by 20.9 percent.
- Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in 29 CFR 1910.146 sub G. “Occupational Health and Environmental Control.”
- Any other atmospheric condition that is immediately dangerous to life or health. (IDLH)

Hydrogen Sulfide Gas

Hydrogen Sulfide (H2S) is a gas with a rotten egg odor, produced under anaerobic conditions. Hydrogen Sulfide gas is particularly dangerous because it dulls the sense of smell, becoming unnoticeable after you have been around it for a while.

The gas is:

- ***Poisonous to the Respiratory System***
- ***Flammable***
- ***Colorless***
- ***Explosive***
- ***And Heavier than Air.***

Hydrogen Sulfide Gas cont…

OSHA lists the following health effects from increasing levels of hydrogen sulfide (in ppm per volume) as they relate to exposure time:

- At 2-5 ppm, prolonged exposure may cause nausea, tearing of the eyes, headaches, or loss of sleep. Some asthma patients may experience airway problems (bronchial constriction)

- At 50-100 ppm, people experience slight conjunctivitis (“gas eye”) and respiratory tract irritation after 1 hour. Some also may experience digestive upset and loss of appetite.

- At 100 ppm, most people suffer coughing, eye irritation, and loss of smell after 2-15 minutes, altered breathing and drowsiness after 15-30 minutes, and throat irritation after 1 hour. Symptoms gradually increase in severity over several hours. Death may occur after 48 hours.

- At 500-700 ppm, most people start staggering and then collapse within 5 minutes, and the eyes will be seriously damaged in 30 minutes. Death occurs in 30-60 minutes.

Gas Monitors

Multi gas or 4 gas monitor.

Gas monitors/detectors should continuously measure:

- Carbon Monoxide (CO)
- Hydrogen Sulfide (H2S)
- Oxygen (O2)
- And combustibles in ambient air.

Inspecting Collection Systems

Inspection and testing of collection systems are the techniques used to gather information to develop operation and maintenance programs to ensure that new and existing collection systems serve their intended purpose on a continuing basis.

Inspection and Testing are necessary to accomplish these tasks:

- ***Identifying existing or potential problems***
- ***Evaluating seriousness of defects***
- ***Determining exact location of problems***
- ***Providing detailed information about system problems that can be reported.***

CCTV Inspection Equipment

CCTV trailer/van or truck

IBAK

CUES

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CCTV

- CCTV Inspection provides positive and reliable answers to what, where, how bad, and how much in a way that is very informative for collection system operators.
- CCTV overcomes the guesswork and can save thousands of dollars on pipe replacement work or repairs. Helps fine tune where the issues are and where to spend money for rehab or repairs.

Purpose of CCTV

- A CCTV inspection of the collection system can be conducted for the following reasons.
  - Inspect conditions and determine the location of problem area such as pipe or joint separations, drops, ruptures, leaks, service connection locations, obstructions, corrosion, improper pipe alignment and root intrusion.
  - Look for damage caused by other excavations or construction nearby.
  - Search for unrecorded connections such as illegal taps.
  - Locate I&I
  - Inspect repairs or new connections
  - Evaluate effectiveness of cleaning operations.
  - Use to locate buried or lost manholes.

CCTV Components

Camera

Power Cable Reel

Monitor for viewing

Winch

GIS

Power Source – Generator

Lights

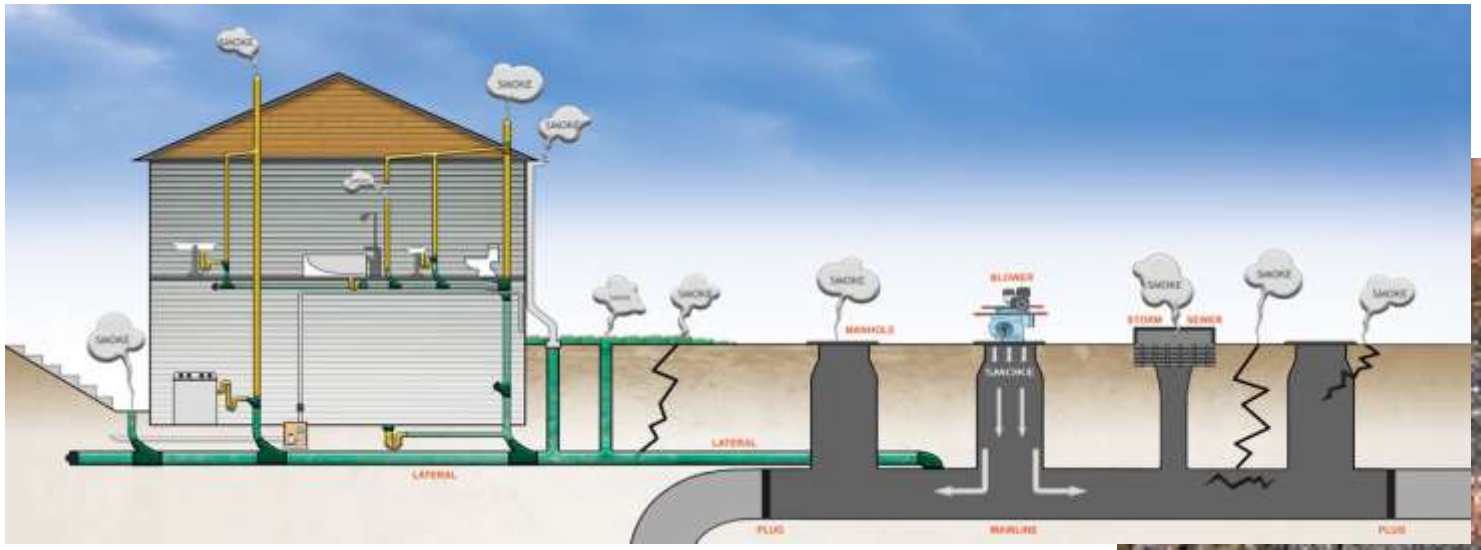
Video Unit

Power Control

Footage Counter

Recording Equipment/software

Smoke & Dye Testing



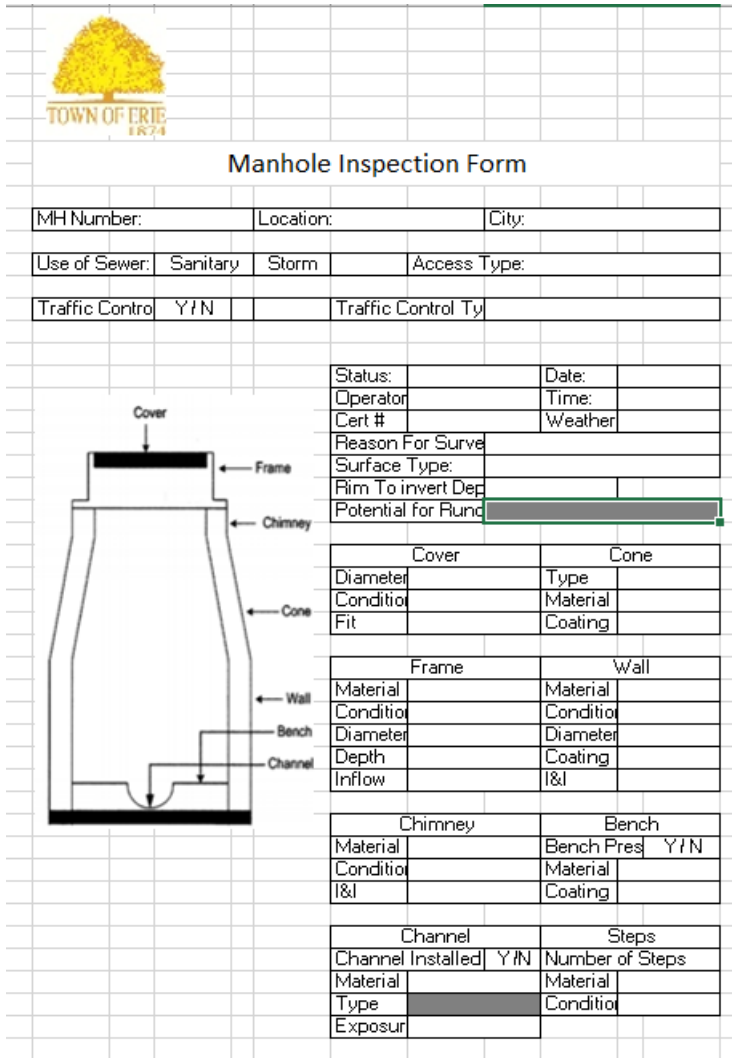
- Smoke Testing is used to find the sources of entry to the collection system.
- Dye Testing is used to establish positively if certain facilities or fixtures are connected to the collection system.

Manhole Inspections

Manholes are part of the collection system and will require the same inspection and attention as the rest of the sewer network. The objectives of manhole inspection are to determine if the manhole is performing its intended job.

Any new manhole should be carefully inspected before acceptance in the same manner as the rest of the system. Existing manholes should be inspected once every 1 – 5 years and those in heavy traffic areas should be inspected more often.

Manhole Inspection Form



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Manhole Inspection Form

MH Number:		Location:		City:	
Use of Sewer:	Sanitary	Storm		Access Type:	
Traffic Contro	Y / N			Traffic Control Ty	

Status:		Date:	
Operator		Time:	
Cert #		Weather	
Reason For Surve			
Surface Type:			
Rim To invert Dep			
Potential for Rund			

Cover		Cone	
Diameter		Type	
Condition		Material	
Fit		Coating	

Frame		Wall	
Material		Material	
Condition		Condition	
Diameter		Diameter	
Depth		Coating	
Inflow		I&I	

Chimney		Bench	
Material		Bench Pres	Y / N
Condition		Material	
I&I		Coating	

Channel		Steps	
Channel Installed	Y / N	Number of Steps	
Material		Material	
Type		Condition	
Exposur			

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Manhole Inspection Cont…

During a manhole inspection the operator will need to thoroughly scan all surfaces and joints inside the manhole and document the locations and types of any observed defects on the inspection form, including:

- Cracks or breaks in the walls or bottom
- Infiltration and estimate the flow in gallons per minute (gpm)
- Joint security
- Offsets or misalignment of any parts
- Root intrusions
- FOG accumulations
- Gravel or debris accumulations in invert
- Grout or concrete in invert causing turbulence
- Deterioration
- Condition of steps or rungs
- Debris on shelf, steps, or rungs
- Slow or sluggish flow
- Corrosion

Keep Records

Whether it’s preventative, emergency or repair work. Make sure to document and keep track of the work performed.

Sanitary Sewer Overflow

Sanitary Sewer Overflow (SSO) is a release of untreated or partially treated sewage from a municipal sanitary sewer.

- SSOs occasionally occur in almost every sewer systems, even though systems are intended to collect and contain sewage that flows into them. Usually an indication that something is wrong. –EPA.gov

Proposed SSO Rule

Collection systems that are improperly maintained and operated often-times lead to SSOs due to increased flow in the system (infiltration/inflow), pipe failures and manhole deterioration.

The EPA considers sanitary sewers to be the most deteriorated part of the wastewater infrastructure and the concern for potential risk they have on human health.

On May 29, 1999 the EPA began to develop a program that would monitor and regulate SSOs which resulted in the SSO Rule under the National Pollutant Discharge Elimination System (NPDES) permit which was released in January of 2001.

The SSO Rule consisted of three standard permit conditions for owners of sanitary sewer collection systems which are:

- Capacity, management, operation, and maintenance (CMOM)
- Prohibition on SSOs
- Reporting, recordkeeping, and public notification.

Under the SSO Rule, the EPA also intended to expand the NPDES permit to include satellite collection systems as well as a watershed management approach with the SSO Rule to prioritize environmental efforts within a given area.

CMOM

- CMOM programs are a best practice for collections system owners and operators. A CMOM program is an information-based program to effectively run a collections system and help lower the risk of National Pollutant Discharge Elimination System (NPDES) permit violations and discharge violations.
- In 2005 the EPA published a guide to evaluating and structuring a CMOM program. This approach is not enforced by regulatory authorities, nor is it legally binding, but can be mandated as a response to consent decrees.

CMOM Operations and Maintenance

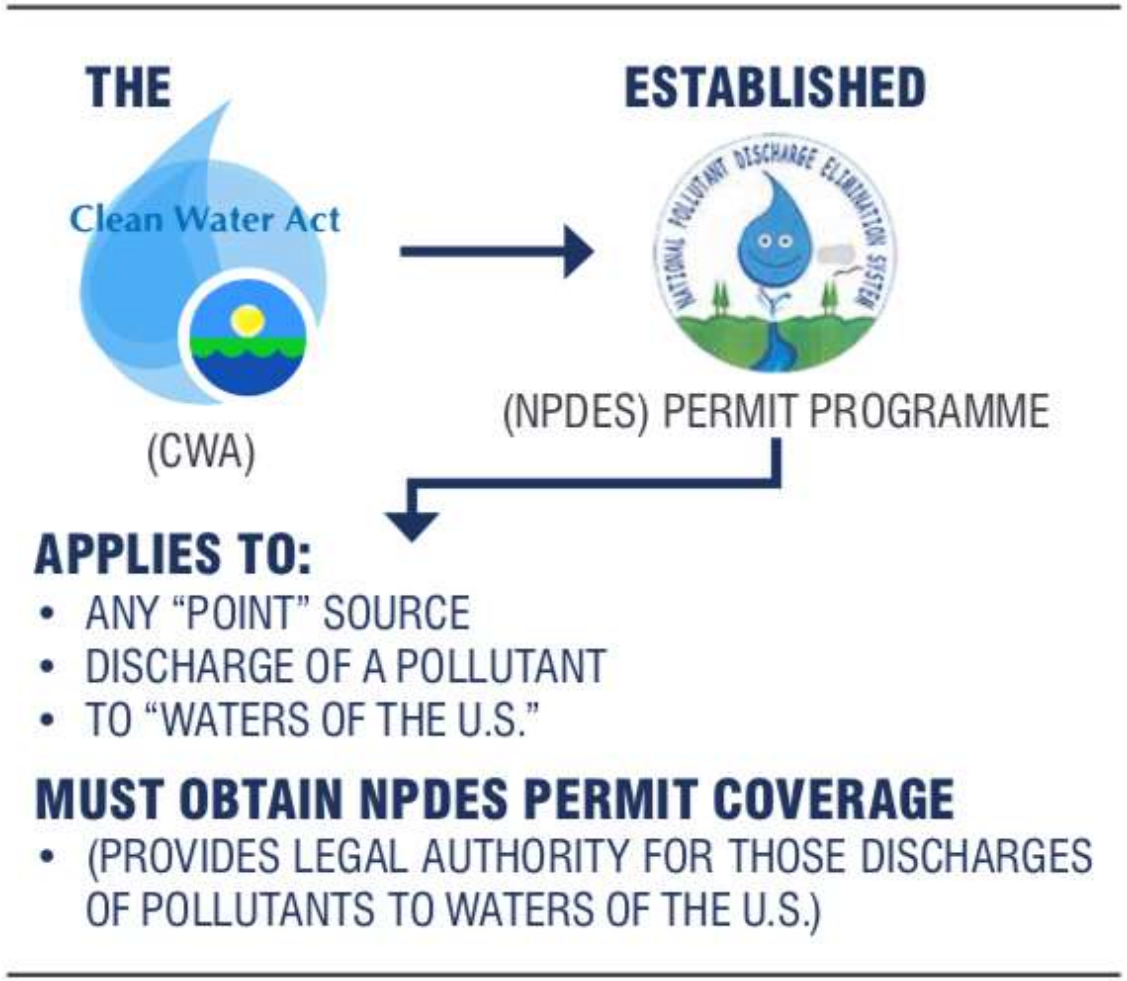
CMOM was intended to reduce the environmental impact and overloading of Treatment Facilities caused by SSO's and CSO's by establishing and instituting known practices and principles of Collection System Operations and Maintenance (O&M).

- Knowledgeable Personnel – Certified Operators
- Goals and Objectives – Prevent Public Health Hazards
- Budgeting – Managing funds appropriately
- Planning – Capital Improvement Projects (CIP) & Asset Management
- Customer Service – Handle disruptions in service in a timely manner
- Protect your investment – Regular maintenance and capacity management (I&I)
- Response plan – On Call Personnel
- Safety and Training – Establish safe practices and provide ongoing training

Wrapping it up with The CWA

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name in 1972.

Under the CWA, EPA has implemented pollution control programs such as setting wastewater standards for industry. EPA has also developed national water quality criteria recommendations for pollutants in surface waters.



That’s all for now…

All this information can be found in the Operation and Maintenance of Wastewater Collection Systems book Volume I & II.

Other Sources:

- Town of Erie
- EPA
- Google images
- Dukes root control
- Freepik
- Flaticon
- IBAK
- CUES
- Rausch
- Aries

Questions?