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## CHAPTER 12: OPERATIONS & MAINTENANCE

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*Figure 12-1: A combination sewer cleaning truck is used to hydro-flush and vacuum sewer lines. The nozzles and tools used with similar trucks have advanced dramatically over the past 10 years. Photo provided by Municipal Maintenance Equipment.*

### Operations & Maintenance

Ceramics are among the most abrasion-resistant materials known. As a ceramic, VCP is the most abrasion-resistant, commonly-used sanitary sewer pipe material. The abrasion resistance has always been an important material property of VCP, but it has become essential as modern cleaning methods intensify the concern.

The principal goal in maintaining any gravity flow sewer is to keep them clean, unobstructed and functioning as designed. A sewerage system, although buried, cannot be neglected. A properly designed and installed sewer must be maintained. Municipalities worldwide are taking a proactive and predictive approach to sewer maintenance, improving the consistent, long-term performance of their sewer systems, thus reducing Sanitary Sewer Overflows (SSOs).

Cleaning, repairing and inspecting sewer lines are essential parts of maintaining a properly functioning wastewater infrastructure and protecting the environment. From the cleaning method using hickory sticks and scrapers employed at the turn of the 20th century, to



*Figure 12-2: Hydro-jetting set-up for an 8" VCP pipe.*

the modern high pressure hydro-jetting trucks and nozzles in use well into the 21st century, VCP has withstood both chemical and mechanical cleaning methods for over 100-years. Clay pipe manufactured well-before the modern cleaning methods were envisioned stands up to the extreme conditions introduced by these methods.

The maintenance departments of municipalities continuing to specify VCP have realized the benefits of the abrasion-resistance and inert nature of clay as a fired ceramic. And that's just one reason the maintenance departments of those municipalities have become proponents of VCP. The durability of VCP pipe is a testament to its manufacturers. Thousands of miles of VCP sewer pipe are cleaned and inspected each day. These same pipes will withstand the next century of technological changes and advances in sewer maintenance practices.

## VCP Sewer Cleaning Methods

### Hydro-Jetting

Hydro-Jetting is one of the most common and most effective forms of cleaning sewers.

Water is pumped into the sewer through a hose directing high pressure jets of water against the pipe wall via a nozzle.

Hydro-jetting removes debris and grease build ups, cuts roots, clears blockages and flushes the sewer pipe. The nozzle is typically sent upstream from a manhole structure and pulled back under pressure, typically 50 to 80 GPM at 2500 to 3500 psi. Debris is then removed by means of vacuuming or by utilizing specialty hand tools.

### Nozzles

The most common and effective nozzels are Static and Rotational, which have replaceable jets allowing the operator to trim the nozzle to the flow rate and pressure of the pump to achieve maximum working efficiency. Static and Rotational nozzles are available with a wide range of jet angles to fit any cleaning need.

**Static Nozzles:** Non-rotational fixed nozzles are manufactured in a variety of sizes and shapes that meet the cleaning criteria.

Cleaning nozzle - primarily used to clean the entire circumference of smaller diameter sewer pipes. Jets are radially located, using a higher jetting angle (21 to 45 degrees).

Flushing nozzle - primarily used to move debris from the bottom of smaller sewer pipes with the use of radially located, lower degreed jets (6 to 20 degrees).

Stoppage nozzle - used to break up sewer blockages with the use of forward facing jets and rear facing thrust jets which penetrate and break-up a stoppage.



**Figure 12-3:** Static cleaning hydro-jet nozzle.  
Photo provided by Advanced Infrastructure Technologies.

**Dredging nozzle** - weighted nozzle primarily used to move debris from the the bottom of larger sewer pipes with the use of lower degressed jets (6 to 20 degrees).

**Rotational Nozzles:** A series of nozzles delivering water jets throughout the entire internal circumference of the sewer pipe, using a revolving head.



**Figure 12-4:** A rotational nozzle uses a revolving head to deliver water jets throughout the entire circumference of the pipe. Photo provided by StoneAge Inc.

**Governed** - this type of rotational nozzle utilizes an internal clutching mechanism to govern the rotational speed of the nozzle head delivering a consistent jetting speed and impact to the pipe wall. Rotational nozzles are available with a wide range of jet angles to fit any cleaning application.

**Spinning** - these non-governed nozzles deliver variable speed and velocity water jets to the circumference of the pipe based on the pressure and volume. Both pressure and volume can be adjusted by the operator at the pump control.

Whether it’s a Rotational or Static hydro-jet nozzle, a low number of larger orifice jet inserts will ensure greater force and cleaning strength across the pipe circumference. A higher number of inserts with small orifices will enable more spreading of the water for cleaning while the impact force is weaker across the pipe circumference. See Table 12-1 for a comparison of thrust power and cleaning effectiveness with varying jet angles.

Nozzle Jet Angle (degrees)	Thrust Power	Impact Force / Cleaning Effectiveness
6 to 15	Best	Poor
16 to 20	Good	Low
21 to 29	Balanced jetting angles thrust to impact force cleaning ratio	
30 to 35	Medium - water jets have moderate impact force	Good
36 to 45	Low	High impact force for removing deposits.
46 to 90	Poor	Best – used for removal of calcium, roots, calcified grease, etc.

**Table 12-1:** Thrust Power vs Impact Force / Cleaning Effectiveness.

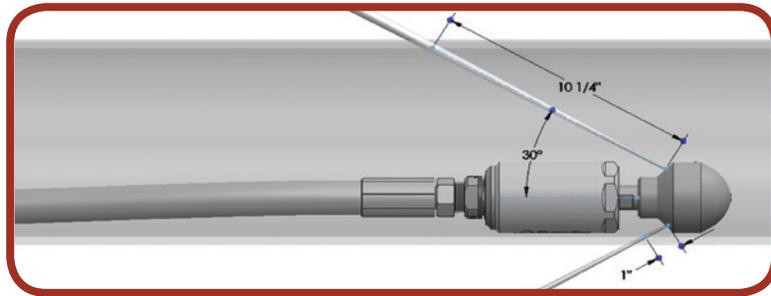
**Nozzle Orientation Management (NOM)**

To prevent “Catfishing” (see definition below) and to obtain the maximum cleaning efficacy for the entire circumference of the pipe, a nozzle or a hydro-mechanical tool should be centered within the pipe.

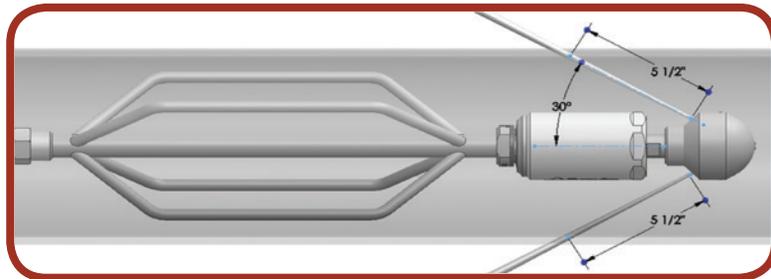
**Catfishing** describes the behavior of a sewer cleaning nozzle when it is dragged across the bottom of the pipe without the use of a skid or centering device. “Catfishing” can reduce the effectiveness of the nozzle and potentially damage the equipment or create a safety concern.

### 8-Inch Pipe with 30° Rear-Facing Jets

Centering of the tool within the pipe can be managed through a finned or wire legged proofing skid, also called a centralizer. This device is essential for effective cleaning of the pipe crown and prevention of mineral deposit buildup. Centering of the tool provides uniform standoff distance as shown in figures 12-5a and b. In these figures, both showing an 8-inch pipe with 30°, rear-facing jets, the standoff distance between the nozzle and the pipe crown is reduced by almost 50% with a centralizer.



**Figure 12-5a:** Without Centralizer- results in a non-uniform standoff distance.



**Figure 12-5b:** With Centralizer- provides a uniform standoff distance

*Illustrations provided by StoneAge Inc.*

Utilization of a centering device not only provides more effective cleaning of the pipe, it is also an integral safety tool during the hydro-cleaning process. A centralizer offers greater control and keeps the cleaning tool from turning up a lateral or turning around in the pipe compromising operator safety .

### Hydro-Mechanical Tools

#### Hydraulic Cutter

A hydraulic cutter is a low rpm, high torque (70 to 100 ft. lbs.) tool that cuts or scrapes the inside of the pipe wall utilizing a circular saw or a series of 3 to 4 indexed flat blades attached to the drive shaft of the hydraulic motor by a chuck.

#### Tap Cutter, Chain/Cable Flail

A tap cutter, chain/cable flail is a high speed cutting tool utilizing an attached chain, cable or cutting can that rotates and scrapes the inside of the pipe to remove roots, hardened debris, protruding laterals and most other solid obstructions.

#### Mechanical Rodding

Mechanical rodders have been utilized with success for cleaning municipal sewers for over 60 years. Because no water is required for cleaning with these machines, their popularity is showing resurgence due to the national water conservation movement.

In FY 2016-2017 the City of Los Angeles saved over 30 million gallons of water utilizing mechanical rodders to clean sewers. The water saved represents roughly the annual usage of 275 households. Mechanical rodders use an engine and a drive unit with hardened continuous rods or sectional rods to push, pull and / or turn various cleaning tools. As the tools rotate they break up grease deposits, cut roots, and loosen debris.

Mechanical rodders can hold approximately 1,200 feet of rod in a reel type cage that can push and pull. These units have a typical pulling capacity of up to 7,000 pounds continuous pull in low gear and 3,500 pounds in high gear.

Mechanical rodders also help thread the cables for CCTV inspections and bucket machines and are most effective in lines up to 15 inches in diameter.

Because the use of mechanical rodding is fully acceptable in VCP, it is a proven water saving material.

### Bucketing

A special device designed to be pulled along a sewer for the removal of debris from the line. The bucket has one end open with the opposite end having a set of jaws. When pulled from the jaw end, the jaws are automatically opened. When pulled from the other end, the jaws close. In operation, the bucket is pulled into the debris from the jaw end and to a point where some of the debris has been forced into the bucket. The bucket is then pulled out of the sewer from the other end, causing the jaws to close and retain the debris. Once removed from the manhole, the bucket is emptied and the process repeated.

### Balling

A method of hydraulically cleaning a sewer or storm drain by using the pressure of a water head to create a high cleansing velocity of water around the ball. In normal operation, the ball is restrained by a cable while water washes past the ball at high velocity. Special sewer cleaning balls have an outside tread that causes them to spin or rotate, resulting in a “scrubbing” action of the flowing water along the pipe wall.



**Figure 12-6:** A continuous mechanical rodding machine has 1200 feet of continuous rod. Photo provided by Haaker Equipment Company.



**Figure 12-7:** An example of a root cutting device used with a mechanical rodder.

## Considerations When Selecting Cleaning Methods

One important consideration when using a mechanical rodder, bucket machine, hydraulic root saw or a chain or cable type cutter is the pipe material in which it will be used.

Equipment manufacturers and government agencies recommend against the use of these aggressive cleaning methods in many of the non-ceramic pipe materials commonly found in sewers today. In the comprehensive manual *Optimizing Operation, Maintenance and Rehabilitation of Sanitary Sewer Collection Systems* (compiled and written under the direction of an advisory committee consisting of representatives of NEIWPC member state environmental agencies, EPA and wastewater consultants) there is information regarding cleaning of plastic pipe:

*“With any mechanical cleaning equipment, the operator must know where plastic pipe has been installed in the wastewater collection system. High-velocity cleaning machines are least likely to damage a plastic pipe system. Power rodders can be used carefully to remove obstructions, but there is always the possibility of damaging the pipe wall if the cutter is suddenly deflected off the blockage and into the pipe wall. Mechanical cleaning tools such as cutters and brushes should not be used in plastic pipe since they can score the pipe and reduce the flow characteristics by increasing the pipe wall roughness. A suitable pipe identification system should be in place to warn the operator where plastic pipe has been installed.”*

VCP manufactured in the U.S. is rated to 5000+ psi with flows exceeding 80 GPM, and at all jetting angles when hydro-flushing. All common methods of cleaning sewer pipe can safely be used in VCP sewer pipe including hydro-mechanical tooling, hydro-flush nozzles, mechanical rodding, bucketing, as well as chain/cable type cutters.

### Safe, efficient, and effective sewer cleaning:

- Safety is always the key element in sewer cleaning. Ensure that all safety measures and manufacturer’s instructions are followed in regards to PPE (Personnel Protective Equipment), traffic control, tool and equipment applications, etc.
- Sufficient jetting thrust to drive the high-pressure hose, nozzle or tool up the sewer.
- Proportionate volume of water to move removed debris towards the recovery manhole.
- Adequate jet impact strength at the outlet of the nozzle or tool to disintegrate and/or remove debris or obstructions.
- Ability to adjust the nozzle or tool to the volume and pressure of water supplied by the high-pressure pump.
- Proper weight of the hydro-flushing tool for use in larger diameter sewers.
- Correct outlet angle of the water jet from the nozzle or tool for the type of cleaning to be performed.
- Center the nozzle in the line.

The information provided in this chapter is not intended to replace the judgement of an experienced maintenance professional. It is intended primarily as a beginning set of considerations for design and maintenance professionals as they consider the long-term implications of material selection in sanitary sewer lines.