SECA

THE FUTURE IN PIPELINE TECHNOLOGY

SEWER INSPECTION & MAINTENANCE

A QUICK GUIDE

GETTING THE JUMP ON SEWER INSPECTION AND MAINTENANCE

Before entering the world of underground sewer assets, many people have little to no understanding of council sewer systems and how essential it is to inspect and maintain assets. Taking a pre-emptive approach to asset management extends asset life, reduces negative impacts on the communities the asset serves, reduces the costs of emergency repairs and protects the environment.

This guide introduces common information about assets, potential issues and maintenance processes to help owners get the jump on sewer system maintenance.

The sewer maintenance industry has a unique terminology, so for convenience, a glossary has been included at the end of this paper. Any words **bolded** in this paper can be viewed in the glossary.

INTRODUCTION

Maintaining sewer assets has numerous benefits, including removing bacteria, biohazards, and chemicals from wastewater, promoting a healthy environmental ecology, and acting as the first line of defence in natural disasters like floods.

Sewer systems transport water from its source to either a treatment plant or to a place for disposal. They comprise two types of sewers (stormwater and sanitary) and components such as laterals, sewer mains, force mains, pump stations, basins, treatment plants, outfalls, maintenance holes and more.

Stormwater and sanitary sewers transport different types of water. Stormwater sewers transport rainwater, runoff and drainage directly to local bodies of water (often untreated), while sanitary sewers transport **greywater** and **blackwater** from households through underground assets to a wastewater plant to be filtered and treated before being channelled back into the environment. These systems typically use one of two configurations.

Combined sewer systems in which all wastewater and stormwater is collected in a single sewer system and separate sewer systems in which sanitary sewer pipes transport blackwater, greywater and industrial wastewater, while stormwater pipes collect surface runoff.

In modern installations, using separate sewer systems is the best practice as it prevents four key issues seen with combined sewers. These are: (1) prevents overloading of treatment plants and sanitary pipes in wet weather events, (2) prevents the risk of environmental contamination by avoiding combining stormwater with heavily polluted sewage, (3) prevents contaminated water from impacting the environment in wet weather events and (4) reduces treatment costs by limiting the water that needs treatment to water from the sanitary pipes.

FOLLOWING THE FLOW

While infrastructure may have some unique variations, it generally follows a standard pathway. Understanding the typical flow of product through the system will help understand the components of the system that need to be monitored and maintained.

As residential and commercial wastewater exits, it starts with moving through the property's plumbing into a **sewer lateral**. The laterals carry the flow through junctions – connection points – to **sewer mains** that serve one or more blocks and run below streets, alleys, and easements.

Wastewater is then discharged from multiple sewer mains into larger **carriers** that carry the waste to **treatment plants** or **outfalls**. If there is not enough elevation for the wastewater to reach the carriers, or the sewer main is lower than the interceptor sewer, the waste will run through a pump station that lifts the water through a **force main** and into the carrier.

WHY MAKE SEWER INSPECTIONS?

As sewer infrastructure ages, deterioration, blockages and back-ups, **sanitary sewer overflows (SSOs)**, diminished capacity, **inflow and infiltration (I/I)**, sinkholes and collapse can be mitigated through inspection and proactive maintenance.

Asset owners, governments, utilities and their subcontractors will undertake a range of activities to monitor their sewer systems, including: inspecting lateral lines to address I/I, **cross bores** and **illicit flows**; conducting inspection, cleaning and repair on sewer lines; inspecting junctions and connections for deterioration; maintaining healthy manholes and pump stations; and monitoring force mains and ensuring they can carry waste fluids under pressure to the discharge point.

Some common contributing factors to pipe failure include the surface weight of the earth causing a pipe collapse; loose soil being washed away and removing support from under a pipe; chemical interactions degrading the line; increased water pressure causing excessive load and pipe bursting; extreme temperature changes contributing to cracks and weakening; and finally untreated defects and flaws in the pipe can deteriorate to the point of pipe failure.

These inspection works are essential to prioritise, plan and budget repairs. By being proactive, owners can ensure that their assets meet regulatory requirements, identify issues before they become emergencies, improve operating efficiency by targeting the defects and deterioration identified, and pre-empt pipe failure to lessen environmental impact.

REGULATORY REQUIREMENTS

In the underground asset industry, it is important to be aware of any regulatory requirements that need to be met. These requirements address many important issues, including laws regarding water pollution, council and industrial requirements, regulations around wastewater and stormwater, inspection requirements, guidance on authorised or certified bodies, and consequences for not meeting regulatory obligations.

Guidelines for water quality management in Australia were developed as part of the National Water Quality Management Strategy (NWQMS). Guideline documents provide information tailored to meet the needs of water quality managers in achieving quality and supply of water that is fit for purpose.

Australia currently has guidelines in place for various types of water management, including:

- Fresh and marine water quality
- Drinking water
- Effluent management
- Groundwater quality protection
- Recreational water
- Recycled water
- Rural land uses for water
- Sewerage systems
- Urban stormwater management

More information can be found about these guidelines on the Australian Government Initiative Water Quality Australia website.

CONSISTENT STANDARDS FOR REPORTING

When gathering information on the conditions of a sewer system, defects and observations must be evaluated and reported with a consistent standard so there can be a universal understanding of the asset's condition. To ensure that this consistency is achieved, pipeline assessment software will draw information from several observation catalogues and can be used to record, organise, analyse and share pipe inspection data.

For example, SECA's WinCan – CCTV Pipe Inspection Software includes supported Counduit Inspection Reporting Standards include the WSA 05-2008, WSA 05-2013, WSA 05-2020 Conduit Inspection Reporting Code of Australia Versions and New Zealand Standard, NZPIM 3rd & 4th Editions.

The software helps to categorise observations (e.g., continuous defects, structural defects, operations and maintenance issues, construction features, miscellaneous features) and displays them in a standard format.

This standard format includes data like defect codes, severity, size, location, video/image number (when using visual inspection technologies), comments, and more. Users implement software's analytical capabilities to identify deterioration trends, determine maintenance priorities, and establish budgets.

DEFECTS AND DETERIORATION

Common sewer defects and deterioration include tree roots growing into pipes; debris causing blockages within a pipeline; deposits of fats, oils and grease (known as FOG in the industry) working with debris to impede flow; protruding traps snagging debris and causing obstructions; offset pipe joints catching debris and causing build-ups/blockages; and sags in the pipe causing debris and solid effluent to settle and obstruct the line.

Other defects and deterioration include **SSOs** and backups, which can contaminate the environment, cause health hazards and damage property. Backups and SSOs can be caused by I/I, which places an increased burden on the system and treatment facilities. Groundwater can also wash pipe bedding into a sewer, creating a depression in the ground or a sinkhole.

SEWER CLEANING

To prevent defects and deterioration from wreaking havoc on a sewer system, it is essential to undertake a regular inspection and cleaning schedule.

Inspection helps locate pipe defects, assess structural and operating conditions, and identify environmental conditions affecting pipes. Inspection methods use both visual and non-visual technologies, with the inspection methods chosen to meet the needs of the sewer infrastructure being assessed.

Cleaning is used to remove foreign material from pipeline systems, remove backups and blockages, increase hydraulic capacity in areas with restricted flow, clear septic solids releasing odour and toxins, or clear the asset for upcoming sewer inspection or rehabilitation activities. There are three major sewer cleaning methods: hydraulic, mechanical and chemical/biological.

HYDRAULIC CLEANING

Hydraulic cleaning refers to any application of water to clean a pipe. These methods include **jetting** (high-pressure water flow scours build-up from pipe walls), **hydraulic pigging** (the pig stoppers the water and is propelled down the pipe, scraping off build-up), **flushing** (large volumes of water flush out the asset) and **scooters** (a rubber rimmed shield pushes water ahead and moves along the pipe scraping down heavy debris and grease).

MECHANICAL CLEANING

Mechanical cleaning employs physical devices to scrape, cut or pull material from the sewer. These methods include **power bucket cleaning** (a cylindrical machine with hinged jaws scrapes large deposits of solid waste into its bucket) and **power rodders** (a thin metal rod with a cleaning head sized to the diameter of the pipe is rotated by an electric motor to cut through blockages and scrape down pipe walls).

CHEMICAL CLEANING

Chemical/biological cleaning can address odours, grease build-up, root growth, corrosion, and insect and rodent infestation.

SEWER INSPECTION

While inspections do take place in an emergency, asset owners undertake assessments as part of a routine of scheduled activities to proactively identify and catalogue potential issues in the asset and then place their repair into scheduled works. During the inspection phase of cleaning and maintenance, the inspection team will collect visual and non-visual data about the asset, which is used to prioritise repair and replacement.

VISUAL INSPECTION

There are a variety of inspection technologies that give asset owners and inspectors visual insight into the state of sewer systems using cameras. These technologies prevent inspectors from physically entering the sewers, eliminating the health and safety risks of confined space entry. Different types of inspection technologies can be implemented depending on the asset's age and known conditions/characteristics.

Common inspection technologies include **sewer crawlers**, **zoom cameras**, **video nozzles, push cameras**, **digital scanners** and **lateral launches**.

Sewer inspection crawlers are robotic vehicles that provide close, detailed inspection data and can be modified to perform other inspections. Asset owners should note that this can be a costly and labour-intensive method, and some traffic disruption may occur.

Zoom assessment cameras use long-range cameras mounted to telescopic poles to capture real-time footage of the pipe. It is lowered through maintenance holds. This is one of the quicker and more accessible inspection options, as it is highly portable, easy to train staff to use and less costly than other inspection methods. Asset owners should note that this is less effective when used in narrow assets (8 inches or less) and is only valuable for straight pipelines.

A video nozzle is another inexpensive and portable technology. It can be implemented in the cleaning stage, as the camera is mounted to the jetter hose. Asset owners should note that live viewing is not usually available from this camera, and its use may not meet regulatory requirements for official assessment purposes.

Push cameras are a quick and affordable option for manual inspection of small diameter drains, laterals and lines and can be deployed from residential access points. Asset owners should note that this has a limited range and does not work well for larger lines.

Digital scanning systems deliver more comprehensive imagery than other camera technologies. The way the computer processes the video to create the scan enables a quick, efficient inspection and creates easily shareable data. Asset owners should note that this technology is not suitable for small assets, and while initial costs are higher than CCTV, its increased efficiency will quickly balance this out.

NON-VISUAL INSPECTION

Non-visual inspection is an essential counterpart to the visual inspection component. Non-visual technologies can assess geometric changes to the pipe, pipe wall thickness, deformations, sagging, voids, collapses, ground conditions and I/I.

Non-visual inspection technologies include **acoustic assessment systems**, **electrical leak locations**, **other leak testing methods**, **laser profiling**, **ground-penetrating radar** and **geospatial probes**.

Acoustic technologies measure vibrations and sound waves. Acoustic technologies include leak detectors, blockage detectors, monitoring systems, sonar probes and ultrasonic probes. Acoustic assessment methods can identify leaks, measure the level of pipe obstruction, detect prestressed wire breakage, and characterise submerged defects, debris, corrosion/erosion and flaws.

Leak testing can use an electrically charged probe, smoke, dye and pressure testing. The leak testing method will depend on the type of asset being assessed and its location.

Laser profiling inspects non-submerged pipe to analyse pipe ovality, alignment, diameter and geometric information. This can provide a starting point for pipe rehabilitation, measure deterioration and perform quality control on newly installed assets.

Ground-penetrating radar emits high-frequency radio waves into the ground to locate utilities, tunnels and other underground assets. Geospatial probes provide location and mapping for assets in real-time from within a sewer line; they can be used to create a 3D model.

INSPECTION ACCESSORIES

It is important to note that sewer inspection activities may require equipment outside of the actual inspection technologies themselves. This may include:

- An outfitted truck or van, with power supply, storage, operator console, work area and washdown system.
- A lowering device.
- Washdown system.
- Maintenance hole rollers.
- Inspection software.
- Above-ground locator.

SEWER REPAIR AND REHABILITATION

Sewer repair and rehabilitation is the final step in sewer maintenance. Repair and rehabilitation aim to maintain or increase an asset's structural integrity, limit capacity issues created by I/I and protect the environment from contamination caused by **exfiltration**. In the past, excavation and replacement was the preferred method for fixing pipeline issues; however, more recently, the industry has moved towards a preference for **trenchless** solutions, which are aimed at minimising the impact on the environment and community while providing sustainable repairs.

Sewer repair and rehabilitation comprises several different methods:

- Pipe bursting
- Slip-lining
- Cured in place pipe (CIPP)
- Deform/reform
- Mechanical point repair
- Injection methods
- Cement grout
- Spray lining
- Pipe reaming
- Rerounding

TALK THE TALK

There are a lot of technical terms and unique jargon in the sewer maintenance industry. This glossary offers an overview of standard terms you may hear.

Term	Category	Definition
Acoustic assessment	Non-visual inspection	Acoustic technologies measure vibrations and/or sound waves.
Acoustic blockage detectors	Non-visual inspection	An acoustic assessment that measures how sound travels through a pipe. A transmitter at one maintenance hole emits tones, and a receiver listens for them at the next maintenance hole. The system then produces a score indicating the level of obstruction in the pipe.
Acoustic leak detectors	Non-visual inspection	An acoustic assessment that listens for the unique sound signature produced by leaks.
Acoustic monitoring systems	Non-visual inspection	An acoustic assessment that detects the breakage of prestressed wire within a pipe. These systems do not identify individual defects but can help determine when further investigation is required.
Backup	Sewer issues	Occurs when a sewer pipe becomes obstructed, causing effluent to accumulate upstream, eventually reaching residential or commercial plumbing.
Blackwater	Wastewater	Water from toilets, comprising urine, faeces, flush water and cleaning materials.
Blockages	Sewer issues	Blockages can be caused by an accumulation of material in the pipe, root intrusions or protruding taps. These may catch debris, causing a build-up of solids that eventually blocks the sewer.
Catch basins	Sewer system	A large underground reservoir that collects and disperses runoff water.
Cement grout	Repair and rehabilitation	A rehabilitation technique where a cement grout is applied to the pipe through injection, robotically, or manually by a worker. Cement can also be spin cast, where a uniform layer is deposited on the pipe wall as a spray head is pulled from one end of the pipe to the other.
Clean-out	Sewer system	A vertical pipe connecting a lateral to the surface, giving easy access to the lateral for cleaning and inspection.
Cross bore	Sewer issues	An issue when a utility line intersects an existing underground sewer pipe causes a blockage.
Culverts	Sewer system	A structure that channels water past an obstacle or channels a subterranean waterway.
Cured in place pipe (CIPP)	Repair and rehabilitation	A rehabilitation technique where a flexible felt liner impregnated with resin is inserted into the line, generally through inversion. Hot water, steam, UV light or ambient temperature is used to cure the resin. The resin bonds tightly to the old pipe wall to form a seal.
Decreased hydraulic capacity	Sewer defects and deterioration	A build-up of sediment, roots, intrusions (protruding taps or other foreign bodies), grease and other material can restrict the capacity of a sewer, causing surcharge or flooding.

Deform/reform	Repair and rehabilitation	A rehabilitation technique where a flexible pipe is deformed, often by folding, and inserted into the host pipe. It is then heated using hot water or steam to reform and fit it to the host pipe.
Deposits	Sewer defects and deterioration	Fats, oils and grease (FOG), sediment and debris may impede flow.
Digital scanning	Visual inspection	Digital scanning systems use wide-angle cameras to capture video frames at regular intervals as they advance down a pipe. A computer digitises the frame and extracts a ring of pixels corresponding to a small pipe ring. Using a geometric algorithm, the computer slices this ring at the top and unfolds it into a rectangle. These rectangles are created from each subsequent video frame, and they are stitched together into a complete side scan.
Electrical leak location	Non-visual inspection	This technology detects leaks using an electrically charged probe pulled through a surcharged, non-conductive pipe – leaks provide a path to the ground, which can be measured to determine leak location and severity.
Flushing	Hydraulic cleaning	Flushing uses a tanker or fire hydrant as a water source to flush a sewer pipe clean with large volumes of water from the upstream end of the collection system.
Force mains	Sewer system	Pipes used to connect a pump station to an interceptor sewer may connect to an adjacent interceptor or carry it a considerable distance under pressure before discharging it.
Geospatial probes	Non-visual inspection	Geospatial probes provide real-time, accurate positional data from within a sewer line. These probes contain accelerometers and other motion-sensing technology to record acceleration, velocity and location. Positional data is recorded as an array of XYZ coordinates, which can be used to create a 3D model of the pipe as the probe moves. This model can be exported to a CAD or GIS platform for further analysis.
Greywater	Wastewater	Water generated from sinks, dishwashers, showers, washing machines and bathtubs.
Ground-penetrating radar	Non-visual inspection	Ground-penetrating radar is used to locate utilities, tunnels and other underground assets. A transmitting antenna emits high-frequency radio waves into the ground. The reflected signal is recorded by a separate receiving antenna and analysed to determine the position and depth of underground assets. Similar technology can be deployed in-pipe to identify voids in pipe bedding.
Hydraulic pigging	Hydraulic cleaning	Hydraulic pigging restricts effluent flow, propelling the pig down the line. The edges of the pig scrape the wall as it travels to dislodge debris and deposits.
Inflow/infiltration (I/I)	Sewer defects and deterioration	When groundwater and stormwater enter a sewer system, this is inflow and infiltration; infiltration occurs when groundwater seeps into sewer pipes through cracks, leaky pipe joints and/or deteriorated maintenance holes; inflow is stormwater that enters the sewer system through rain leaders, basement sump pumps or foundation drains illegally connected to the sewer.

Injection methods	Repair and rehabilitation	A rehabilitation technique where a resin or chemical grout is pressure-injected into cracks, holes, joints and the annular gaps of lateral connections helps solve infiltration issues. Resin (polyurethane or silicate) can also structurally stabilise lines by filling voids in the surrounding bedding.
Inspection software	Inspection accessories	Software used to record, archive and analyse inspection findings.
Interceptors	Sewer system	Pipes (typically 10+ inches in diameter) that carry waste discharged from one or more sewer mains to a treatment plant or other disposal point.
Jetting	Hydraulic cleaning	Jetting (also called high-velocity cleaning) is where high-pressure water is fed to a nozzle. Jets within the nozzle direct flow backward, propelling the nozzle forward while scouring material build-up from pipe walls.
Laser profiling	Non-visual inspection	Laser profiling allows analysis of pipe ovality, alignment, diameter and capacity to create a profile. A laser probe scans a pipe's cross-section over its entire length. The profile provides detailed geometric information about the pipe, allowing for accurate liner design, quality control on new pipe installations, and measurement of erosion/corrosion rates.
Lateral launch	Visual inspection	A lateral launch system allows inspection of laterals from an adjoining mainline. It is like a sewer inspection crawler but has a secondary camera that is propelled into a lateral like a push camera.
Laterals	Sewer system	Pipes (typically 4-6 inches in diameter) connecting individual properties to the public sewer system.
Locator	Inspection accessories	Used above-ground to find the position of underground equipment (such as a crawler or push camera) outfitted with a sonde transmitter.
Lowering device	Inspection accessories	A device used to lower an inspection crawler into a sewer that protects crawlers and their cables from damage.
Maintenance hole roller	Inspection accessories	Protects the crawler cable as it passes over the lip of a maintenance hole and from the maintenance hole into the mainline, respectively.
Maintenance holes	Sewer system	Street-level openings that allow easy access to sewer components for cleaning and inspection.
Mechanical point repair	Repair and rehabilitation	A rehabilitation technique where a steel sleeve with a rubber seal is inserted into a line on a balloon packer. The rubber is compressed against the wall to seal out I/I. The steel sleeve locks in place to provide structural support.
Obstructions	Sewer defects and deterioration	Debris, rocks and pipe material in a line can block flow and snag other debris.
Odour	Sewer issues	Solids remaining in a system for long periods can turn septic and produce toxins like hydrogen sulphide.
Offsets	Sewer defects and deterioration	Pipe joints that become misaligned, creating a lip that catches debris.
Other leak testing	Non-visual inspection	Smoke, dye and pressure testing can also find leaks, depending on the type of line and where it is located.
Outfall	Sewer system	The point, location or structure where stormwater or treatment plant effluent discharges to the environment.

Pipe bursting	Repair and rehabilitation	A rehabilitation technique where a tapered expansion head is pulled through the line, pushing the pipe wall outward until it shatters. The broken pieces are pressed into the surrounding soil, and a new pipe is pulled in behind the head.
Pipe reaming	Repair and rehabilitation	A rehabilitation technique where a tapered drill head is pulled through a line, breaking the existing pipe into pieces. Instead of being pushed into the surrounding soil, the broken pieces are suspended in fluid and moved into a recovery pit or maintenance hole ahead of the drill head. A new line is pulled into place behind the head.
Power bucket cleaning	Mechanical cleaning	Power bucket cleaning uses a cylindrical device that is closed on one end with two opposing hinged jaws at the other. They scrape material from the pipe and deposit it in the bucket as the jaws open.
Power rodders	Mechanical cleaning	Power rodders use an engine and drive unit with continuous or sectional rods. As blades at the end rotate, they break up grease deposits, cut roots and loosen debris.
Protruding taps	Sewer defects and deterioration	Service lines that jut into the mainline can snag debris, obstruct flow, and prevent inspection and cleaning equipment from passing.
Pump stations	Sewer system	Lift wastewater when there is not enough elevation difference to rely on gravity or when a source sewer is below the receiving sewer (this may be a gravity sewer or a force main).
Push camera	Visual inspection	Push cameras consist of a video camera head with illumination mounted to a push rod that is manually pushed into drains, laterals, and other small diameter lines to capture footage.
Rerounding	Repair and rehabilitation	A rehabilitation technique where a carrier is pulled into place and expanded, pressing the deformed section of pipe outwards to make it round again. A stainless steel clip attached to the carrier is pressed outwards, as well, to maintain the correct shape of the line.
Roots	Sewer defects and deterioration	Tree roots gravitate towards the moisture around pipelines and grow into the pipe, causing damage and obstructing flow.
Sags	Sewer defects and deterioration	Low areas in a pipe where debris and/or solid effluent may accumulate, causing a blockage or backup. They are often due to geological events (erosion, settlement, earthquakes) or human error (poor soil compaction, improper installation).
Sanitary sewer overflows (SSOs)	Sewer defects and deterioration	SSOs are releases of untreated sewage into the environment, which can happen when wastewater overflows from underground pipes through a maintenance hole, clean-out or broken pipe.
Scooters	Hydraulic cleaning	Scooters are round, rubber-rimmed, hinged metal shields mounted on a steel frame with small wheels. The shield works like a plug to build-up ahead of the water. The scooter then scours the pipe's inner walls clean as it moves along the line.

Service truck	Inspection accessories	A truck outfitted with sewer inspection equipment, a power supply (generator or inverter), cabinetry for equipment storage, a washdown system, an operator console with controls, and a work area to clean and maintain equipment post-inspection.
Sewer inspection crawler	Visual inspection	Robotic vehicles that navigate through sewers for an up-close view of pipe condition. Illumination is provided by small, high-intensity lights surrounding the camera. The camera itself is typically equipped with zoom optics and articulation to allow operators to get a detailed look at the damage.
Sewer mains	Sewer system	Pipes (typically 200-255 mm in diameter) installed under a public street, alley or easement that receive waste discharged from laterals.
Sinkholes	Sewer defects and deterioration	Can occur when groundwater washes pipe bedding into a sewer through cracks, gaps and holes, leaving a void in the surrounding soil; as the void grows, it can create a depression in the ground or manifest as a sinkhole.
Slip-lining	Repair and rehabilitation	A rehabilitation technique where a new liner pipe is pulled in from an installation trench and the space between the old pipe and new liner pipe is filled with grout to prevent leaks and provide structural support.
Sonar probes	Non-visual inspection	An acoustic assessment that transmits sound waves through water and then measures their reflection to characterise submerged defects and debris.
Spray-lining	Repair and rehabilitation	A rehabilitation technique where an epoxy compound is spray-blown to form a layer on the walls of a cleaned pipe. Continuous airflow keeps the epoxy in place until it cures completely.
Taps (wyes)	Sewer system	The connection points between a lateral and the sewer main.
Ultrasonic probes	Non-visual inspection	An acoustic assessment that transmits high-frequency sound waves through metal pipe walls and then measures their reflection to characterise corrosion/ erosion and flaws.
Video nozzle	Visual inspection	Video nozzles are water-propelled HD cameras that thread onto a jetter hose and allow cleaning crews to assess pipes post-cleaning to determine whether they need additional attention.
Washdown system	Inspection accessories	A tank of water, pump, hose reel and spray nozzle outfitted on a truck to clean equipment post-inspection.
Wastewater treatment plant	Sewer system	Processes municipal sewage and industrial waste to be reintroduced to the environment with minimal impact.
Zoom assessment camera	Visual inspection	Zoom cameras assess maintenance holes and sewers using a video camera with long-range zoom optics and focused LED illumination, all mounted to the end of a telescopic pole. The camera captures footage that is displayed in real-time on a monitor or tablet. Some zoom cameras allow operators to stream HD video of the pipe through a wi-fi connection.