

Technical publication to Northwest Trenchless Journal

“Geomatics, Integrated Sensors and 3D Imaging”

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INTRODUCTION

Historically, surveying in underground pipes has been the exclusive domain of camera technology. Over time, underground pipes can corrode, degrade, or suffer from structural issues. Integrated sensor inspections can help assess the condition of pipes and determine whether repairs or replacements are needed to maintain their integrity. Also, we have found that historical “as-built” drawings showing pipe sizes and other information may not be accurate. With such aging infrastructure, Municipalities and Cities are looking for a much more detailed understanding of their existing infrastructure.

The costs for inserting a work platform, for a video only inspection, are already accounted for; the additional sensors are a small incremental expense and provide substantial benefits. Our sensor suite enables the creation of accurate 3D models of the sewer lines. These models serve as valuable references for maintenance, emergencies and future expansion. Excavations and construction projects can also potentially damage underground pipes if their locations aren't accurately known. Pipe Meander Mapping can help update utility maps and prevent accidental damage

Client need for high accuracy 3D imaging has driven sensor technology in the direction of sensor integration using closed circuit TV (CCTV), Laser, Sonar, GPS, gas, and temperature sensing and based on a range of differing platform types (Tractor, Float, Remotely Operated Vehicle (ROV), etc.). We refer to this as Integrated Sensor Surveys otherwise known as MSI. Our proprietary inspection systems operate without the need to bypass or de-water thus enabling the acquisition of extremely accurate data and comprehensive assessments of trunk sewers (e.g.) during operation.

Overall, Integrated Sensor Surveys of underground pipes is a proactive approach that helps ensure the safety of communities, protect the environment, and maintain the functionality of critical infrastructure.

A fully integrated and detailed picture of the pipe depends on a sophisticated processing software package. Electronic time delays through the system, both fixed and variable, must be carefully determined, and errors must be either eliminated or calibrated and corrected in software. All inputs related to attitude and location must be corrected and appropriately interpolated. It is important to design the system such that any correctors are small so that errors in the correctors do not have a substantial impact on overall system performance.

Technology now supports the collection of video & XYZ Point Cloud data above and below water using high resolution digital video cameras, lasers (time of flight) and digital profiling sonars. A wide range of pipes can be surveyed 6”/150mm to 21’/6.5 m using a variety of platforms including tractors, ROV and skid mounted or pontoon floats. In large diameter sewers, lighting is key to achieving high resolution images, high quality frame grabs with a capability extending out to long ranges (up to 6,000 ft.). Sonar allows sediment buildup to be identified and quantified along with the distance from the closest Man Hole (MH). When integrated with other sensors it can provide measurement capabilities for pipe diameter; pipe shapes pipe subsidence and the identification of air pockets in siphons.

Platforms include:

- Tractor- and float-based work platforms for pipes, outfalls, which are capable of ranges (in pipe) to 6000’.
- Manhole inspection/survey platform using CCTV and laser sensors for Level 2 (measurements) reporting.
- Pipe ROVs
- Custom/innovative robotic systems and software for specific survey challenges.

For pipe surveys from small 6" (150 mm), to large diameter tunnels there is a range of sensor technologies:-

- High resolution 1080p video, see small details clearly
- Time of Flight 3D laser, (LiDAR) accuracy to 10 mm (3/8") with a dense point-cloud.
- Profiling sonar with a range accuracy of .5% of range.
- Temperature and Gas (H2S) sensors.
- RTK GPS 2 cm elevation accuracy, calculate gradients between MHs
- GIS ready data, install ready.

AquaCoustic has developed tools for the generation of reports from the raw sensor data, that enables point cloud matching/integration of the various sensor data streams. This combines the laser and sonar data to produce an (X,Y,Z) point-cloud. We then generate a report that allows the client to easily assimilate the information, to make meaningful decisions and of course all the supporting digital data is supplied.

TYPICAL USES OF THE DATA

- Integrated laser/sonar data for pipe deformation/ovality deviation from the "as-builts".
- Pipe Meander Mapping to 10 cm to 30 cm accuracy for mapping old infrastructure including elevation measurements.
- Use of integrated sensors to indicate pipe storage capacity (i.e., how long can water be held back in the event of needed repairs).
- Use of integrated sensors in establishing any water flow restrictions based on measuring pipe cross sectional restrictions.
- Pipe inside dimensions to within 10 mm. Important for the actual pipe volume and pipe hydraulics.
- Pipe lining volumes and shape.

AquaCoustic Remote Technologies Inc. ('AquaCoustic.com") specializes in inspection of structures and assets such as trunk sewers, mine sites, hydro dams, reservoirs, ports, river crossings and bridge abutments using a wide range of sensor technologies to collect highly accurate data that is used by civil engineers to prioritize remedial work for fixed assets. We are both NASSCO PACP & MACP certified. Our clients include civil engineering firms and municipalities, mining firms and infrastructure asset owners throughout North America and the world.

The following Figures show some specific, real-life examples of underground pipe imaging surveys. A specific and unique feature of our CCTV is the very high clarity of the images along with high intensity lighting.

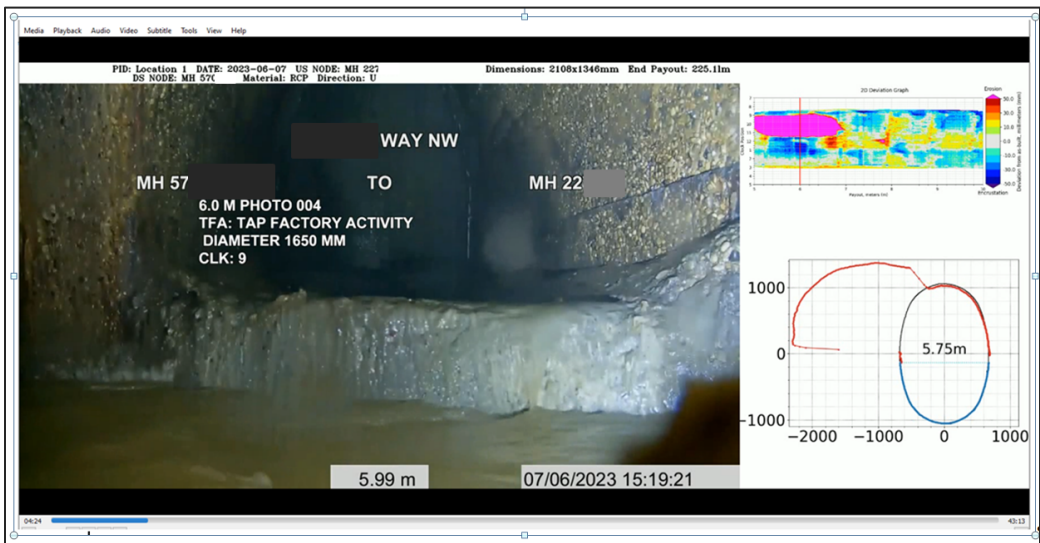
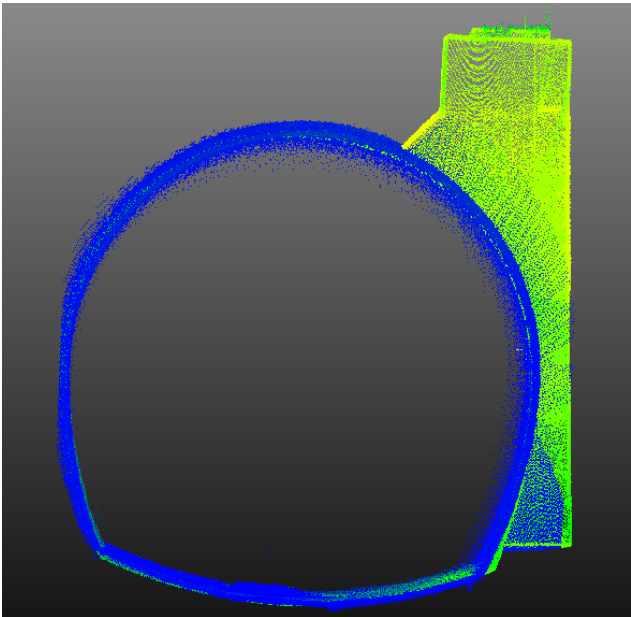


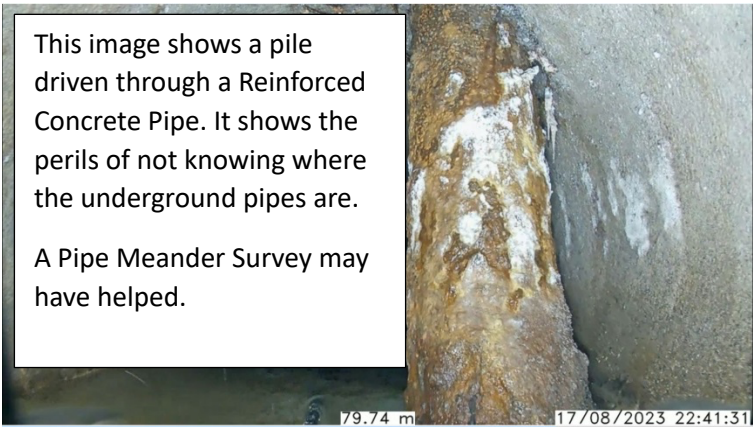
Image shows combined CCTV, LiDAR, and Sonar data. All data is tied to the payout.

This image shows a large tap in the side of the pipe



The benefits of Time of Flight Laser, (LiDAR).

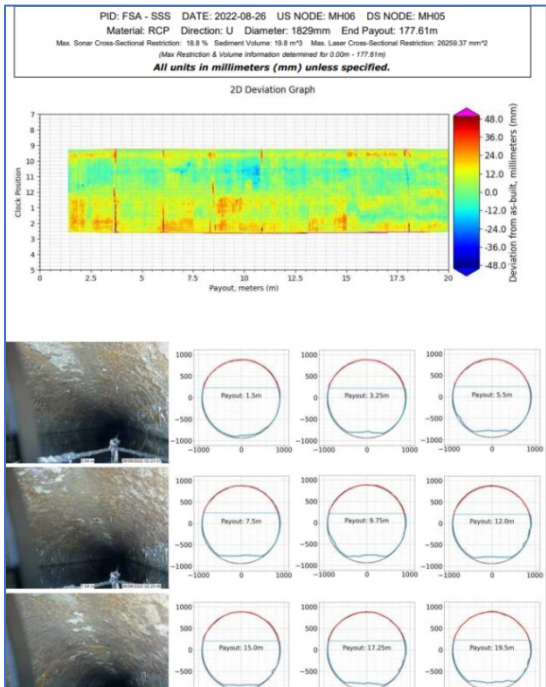
This image shows CAD-ready, laser point cloud data of a MH on the side of a storm drain.



This image shows a pile driven through a Reinforced Concrete Pipe. It shows the perils of not knowing where the underground pipes are.

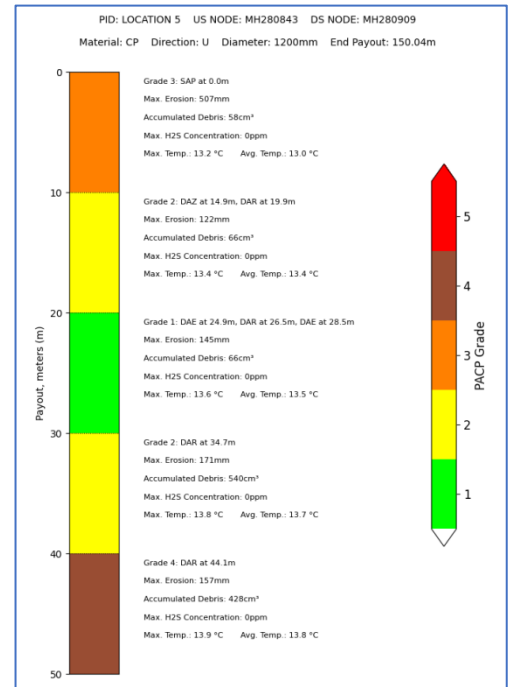
A Pipe Meander Survey may have helped.

79.74 m 17/08/2023 22:41:31



To the left:
 Merged report of the CCTV, Laser, and sonar survey. Showing a graphed deviation from the pipe as-built; sonar and laser cross-section and frame grabs along the pipe.

To the right:
 A summary report showing pipe conditions, coded to PACP standards.



CONTRIBUTIONS

Our new and proven integrated sensor technologies have now demonstrated a number of significant contributions to the geomatics field, namely:

- Proven processing enabling the integration of the more accurate laser data with more coarse sonar for accurate pipe information along the platform track within the pipe.
- New information on pipelining condition using laser and sonar thus enabling accurate internal measurements, information on sediment in the pipe as well as joint strain and undulations in the pipe thus saving a Client significant expense.
- Laser sensors now allow accurate measurements of and within the pipe, including clear erosion and encrustation on pipe walls.
- New capabilities to determine accurate pipe position and possible meandering from aging pipe infrastructure, where both distance and elevation are provided.