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Case Study

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A PROACTIVE APPROACH TO PIPELINE MANAGEMENT: CITY OF VANCOUVER CASE STUDY

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1 Project Overview

1.1 Introduction

To help manage its resilience program, the City of Vancouver (COV) retained the services of Pure Technologies in the spring of 2016 to perform a condition assessment and risk analysis of the 30-year old Powell-Clark Feeder Main, part of the water system that delivers 360-million liters of high-quality water daily throughout nearly eight kilometers of large diameter concrete pressure mains.

A key element to these programs is a physical inspection of the underground piping. The assessment technologies used by COV assist in 1) identifying, localizing, and quantifying the presence of damage in the pipe wall and leaks in individual segments of pipe along the pipeline and 2) providing risk analysis and repair prioritization for pipes identified with damage and leakage.

1.2 Scope of Work

The Powell-Clark Feeder Main is comprised of prestressed concrete cylinder pipe (PCCP) (AWWA C301) and bar wrapped pipe (BWP) (AWWA C303), ranging from 750 to 900mm in diameter. Because this water main needed to remain in service during the assessment, the 6,000 metre concrete pipeline was inspected using free-swimming leak detection and electromagnetic technology.

Over five days in March 2016, COV utilized free-swimming tools to perform electromagnetic (EM) and acoustic leak detection inspections of the subject feeder main. COV also monitored this feeder main using a Transient Pressure Monitor for three months prior to the previous two inspections, for a hydraulic evaluation of the line.

2 Innovation

2.1 Electromagnetic Inspection

The inspection technology chosen had to adequately assess the condition of the pipe at a time when its deterioration level was not at high risk for failure. Electromagnetic (EM) technology provides this assurance by locating prestressing wire-breaks on each individual section of PCCP or BWP, which is the best indicator as to whether this type of pipe will fail. This allows for one deteriorated pipe to be identified within an entire transmission main that is in good condition overall.

For COV, a rapid inspection without adversely affecting customers was essential. For this reason COV chose to use the PipeDiver® inspection platform as the carrying vessel for the EM equipment; a versatile, free-swimming condition assessment tool that operates while the pipeline remains in service.

For the feeder main inspection, the pipeline was depressurized and the tool easily inserted through a blind flange access point installed by COV, and the tool later extracted into a swab retrieval chamber. The EM inspection covered a cumulative distance of 6.1 kilometers and spanned 913 pipes.

Analysis of the data obtained during the inspection determined that one (1) pipe (less than 1% of the line) in the Powell-Clark Feeder Main displayed electromagnetic anomalies consistent with 30 broken prestressed wire wraps. This is well below the average distress rate in PCCP lines, which is 3.8% of pipes in structural distress.

2.2 Transient Pressure Monitoring

Another important input for the structural evaluation is the actual operating pressure of the pipeline, including the working pressure and transient pressures. Hydraulic pressure transients occur in lines when the pressure conditions in the system change due to variances in pressure or flow conditions (e.g., the rapid closure of a valve). A transient pressure wave can travel through the line and can cause damaging pressure spikes and vacuum conditions, which can lead to permanent damage within the pipe wall and failure within the pipe system.

For this inspection, a transient pressure monitor was installed on a hydrant and recorded the internal pressure over three (3) months. An operating pressure of 744.6 kPa (108 psi) and a maximum working pressure of 1057 kPa (153.31 psi) were recorded during this period, which was used for the analysis.

2.3 Acoustic Leak and Gas Pocket Detection

In addition to transient pressure monitoring and electromagnetic inspection, the COV also performed an acoustic inspection to identify and locate leaks and pockets of trapped gas along the main.

The SmartBall® tool is deployed into the water flow and simply travels the line - propelled by the hydraulic flow - and is captured at a point downstream. The highly sensitive acoustic sensor can detect ‘pinhole’ sized leaks and gas pockets and be reported within a typical location accuracy of approximately plus or minus 2 meters. This location accuracy is important especially when digging in a heavily populated urban environment like Vancouver, where an incorrect excavation can lead to expensive repercussions.

For this project, the acoustic tool was inserted into the feeder main through a flange access and acoustic and sensor data were collected and recorded as the tool traversed the line. From the acoustic data, analysis detected three (3) anomalies characteristic of leaks.

3 Lessons Learned

The final report included an identification of all distressed pipe sections in the line and the position and magnitude of the distress. In addition, these pipes were ranked according to the quantitative estimate of the total number of broken wires. Pipes that showed multiple regions or wire breaks were further tabulated showing the distinct wire break regions individually.

Next, structural engineers performed the risk analysis and repair prioritization for pipes identified by EM to have broken pre-stressing wires. It took into account the relationship between the number of broken wires and the internal pressure for each distressed pipe.

Using this data, staff at COV were able to determine which pipes to repair immediately and which ones could wait until a future date. The project has so far yielded a few action items for COV including fixing identified leaks as well as to physically investigate the pipe section with damage.