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Publication date
2016

Document Version
Final published version

Citation (APA)
Makris, K., Lepot, M., & Clemens, F. (2016). *Potential uses of an IR camera to detect and quantify lateral connections in sewers*. 40-41. Abstract from 8th International Conference on Sewer Processes and Networks, Rotterdam, Netherlands.

Potential uses of an IR camera to detect and quantify lateral connections in sewers

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Abstract
Illicit connections are a major reason of the inefficiency of some separate sewers. Despite theirs costs, dye tracing and smoke test methods are common to investigate mis-connections. An infrared camera (FLIR, A35) was used to identify abnormal thermal finger prints (due to lateral connections) along a flume. The illicit connections were simulated by discharging warm or cold water through several types of lateral connections (variation of diameter, intrusion, depth, *etc*.). Data analysis revealed that the detection of both illicit connections and groundwater infiltration is possible, albeit under certain conditions.

Keywords
inspection, IR camera, separate systems, lateral connection, misconnections

INTRODUCTION

The wastewater of approximately 25% of the households in the Netherlands is discharged into separate sewer systems (Schilperoort *et al*, 2013). This tendency for using separate systems for the discharge of different types of water could be easily justified by the several advantages that separate systems have (reduction of health risks, recycling of run-off water, *etc*). However, the major disadvantage that is usually observed is the existence of illicit or mis-connections. The combination with the absence of inspection or treatment of storm water results in the direct discharge of raw sewage to the receiving waters. Very commonly used techniques for the detection of illicit connections are the smoke test and the dye test (Hoes *et al*, 2009) and the use of fiber-optic distributed temperature sensing (Nienhuis *et al*, 2013). While, for most cases, the inspection is usually restricted by the water level within the pipe, the current research strives to give a more comprehensive approach to the detection of illicit connections and groundwater infiltration with the use of thermography.

MATERIALS AND METHODS

Experimental Setup

The experiment took place at the Eastern Scheldt Flume (Figure 1, left) in the laboratory of hydraulics at Deltares: a 50m flume (section of 1 m^2) built with glass and steel. Five windows were replaced for the needs of this study with windows made of acrylate with several lateral connections: diameters ranging from 40 to 200mm, 4 diffusers (vertical, horizontal and 45 degrees angle), different height levels of water entering into the pipe and intrusive connections. Additionally, a tank and a mixer were used in order to provide water with a uniform and constant temperature to the system, representing either sewage (warm water) or groundwater (cold water).

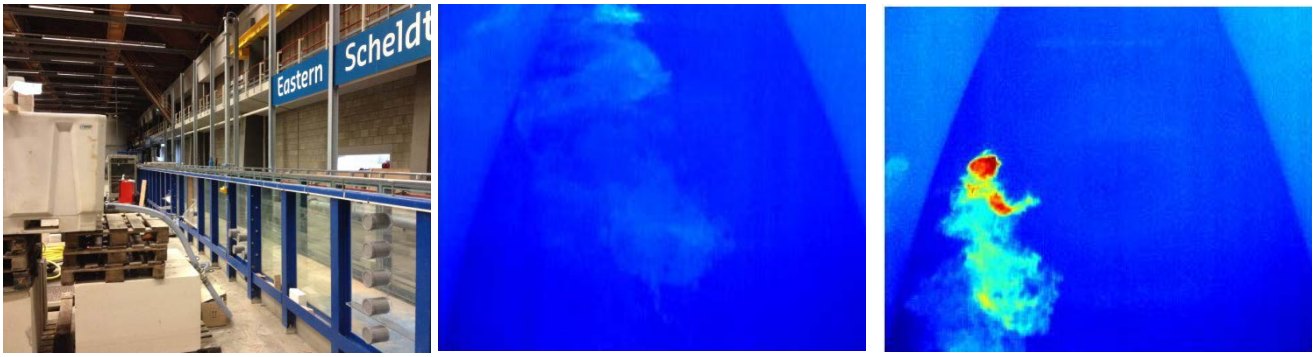

Figure 1. Experimental set up (left). Thermal images downstream (middle) and upstream (right) of a warm (32°C) lateral connection (100 mm of diameter, 0.38 L/s of discharge, 10 cm of intrusive connection) in the flume (19.3°C, discharge of 117 L/s).

The IR camera was placed on a mobile platform, moving from downstream to upstream at approximately 15 cm above the top of the flume. Its position was recorded with a laser distance meter (Dimetix, FLS-C10).

Methods

IR images (frame series) have been processed with Matlab© in order to: *i)* convert pixel to temperature values and *ii)* investigate temperature distributions at the free surface and their variations. While assuming the temperature of the lateral connection, its discharge can be derived from a basic thermodynamic balance.

RESULTS AND DISCUSSION

The results reveal that the detection is possible (Fig. 1, middle and right) but only under certain circumstances: linear lateral connections (built to simulate cracks along a pipe) were not detectable. IR camera identified the other connections.

CONCLUSIONS AND PERSPECTIVES

The preliminary experiments highlighted that laterals connections can be often detected by IR images. Subsequent experiments will be done before March in order to draw the contours of both detection and quantification limits of this new technique.

REFERENCES

Hoes O.A.C., Schilperoort R.P.S., Luxemurg W.M.J., Clemens F.H.L.R., van de Giesen N.C. (2009). Locating illicit connections in storm water sewers using fiber-optic distributed temperature sensing. *Water Research* .

Nienhuis J., de Haan C., Langeveld J., Klootwijk M., Clemens F. (2013). Assessment of detection limits of fiber-optic distributed temperature sensing for detection of illicit connections. *Water Science & Technology* .

Schilperoort R., Hoppe H., de Haan C., Langeveld J. (2013). Searching for storm water inflows in foul sewers using fibre-optic distributed temperature sensing.