Guideline on Leak Detection on Underground Communal Service of Housing Estates

W Water Supplies Department

The Hong Kong Special Administrative Region

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PREFACE

The Water Supplies Department (WSD) has committed to provide adequate and reliable water supply to Hong Kong. As fresh water is so precious nowadays, it is also the WSD's mission to save every drop of water from unnecessary loss.

Tackling the water loss against leakage from buried pipes within housing estates is a good example highlighting the cooperation among the WSD, the management office of the housing estates / Registered Agents of the communal service, and the leak detection industry. Under Waterworks Ordinance (Cap. 102), Registered Agents are responsible for maintaining the communal service and the associated water supply facilities within the premises. This guideline helps them understand what and how they should do on detecting water leakage from underground water pipes to fulfil the maintenance responsibility.

1. DEFINITION OF COMMUNAL SERVICES IN HOUSING ESTATE

Communal service is a part of a fire service or inside service which is used in common by more than one consumer in the same premises as defined under Waterworks Ordinance ("WWO") (Chapter 102). For the case in a housing estate, the section of water pipes, after passing the lot boundary but before reaching the individual meters for the customers, is defined as the communal service.

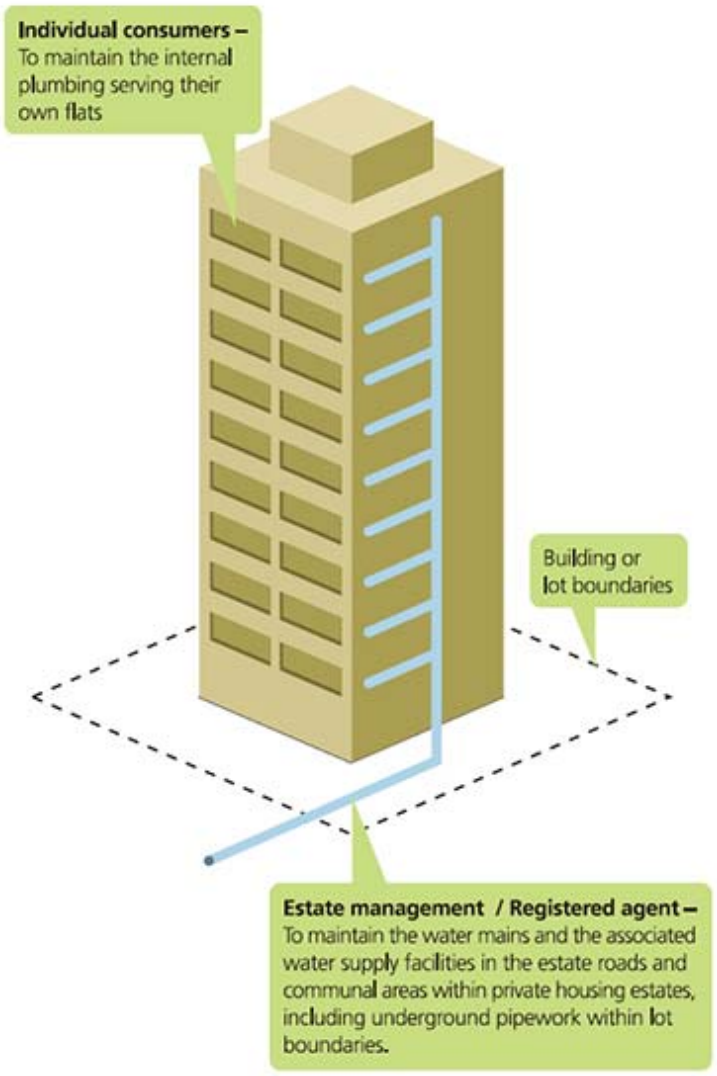

Figure 1 Indicative drawing shown the extent of communal service

2. RESPONSIBILITY OF REGISTERED AGENTS

Registered Agent ("RA") is responsible for maintaining the communal service and the associated water supply facilities within the premises, e.g. estate roads or communal areas, including underground water pipes as required under Section 7 of the WWO. RA is usually the property management office or the owners' corporation of the housing estates. RA has the responsibility to keep the underground water pipes intact without leaking, and repair such leaking pipes when identified.

3. HIDDEN LOSS OF WATER THROUGH UNDERGORUND PIPES

However, due to ageing of inside service, or defective workmanship during installation, there may be water leakage from the pipes within private developments or housing estates. Such leaks, not only are a waste of precious water resource, but also impose danger to residents living in the estate. The leaks may cause failure of a slope or create an underground void that will collapse suddenly when a heavy object passes, without notable signs at the ground surface. The consequent-to-life would be very high for leaking water pipes near slopes.

4. IDENTIFICATION OF WATER LOSS IN COMMUNAL SERVICE

The Water Supplies Department ("WSD") monitors the situation of water loss in housing estates. One of the methods is by comparing the discrepancy ratio in the meter readings between the master meter installed by developer in the housing estate or the bulk meter installed by WSD just outside the inlet point for the housing estate, and the sum of water consumed through all other individual water meters installed in the premises.

5. ENFORCEMENT UNDER WATERWORKS REGULATIONS

When RA suspects, or is informed by the WA that there are signs of leakage of communal pipes, RA shall take action promptly in locating and repairing the leakage. It not only saves the government from the loss of revenue, but also saves lives or property when the leaking pipes are on or near slopes, retaining walls or roads. In general, RA can refer to *"Code of Practice on Monitoring and Maintenance of Water-Carrying Services Affecting Slopes"*[1] which is a guideline for owners to monitor and maintain water-carrying services affecting slope, including communal service.

The WA may issue a repair notice (Form K) under Waterworks Regulation ("WWR") (Chapter 102A) Section 16(1)(a) to the RA when prima facie case for leakage at the communal service is established. The RA shall then promptly carry out investigation and complete the repair works within a specified time limit. The WA may consider restrict or suspend the water supply to prevent the continual waste of water under WWR Section 9(b). If RA fails to do so, the WA may further issue a disconnection notice (Form J) under WWR Section 10(e) for disconnecting the water supply from government mains to avoid wastage.

6. COMMON METHODS IN PINPOINTING LEAK SPOTS

It would be easy to detect leakage from the exposed water pipes by naked eyes but difficult to do so from the buried water pipes. As WSD carry out systematic leak detection procedures in our daily works, this guideline serves as a document introducing the common practice in leak detection that maintenance agents can make reference to and follow.

To pinpoint suspected leak spots, some common leak detection techniques are described below. A model specification on leak detection is prepared at **Appendix A** for reference. The leak detection specialist should first carry out sounding and visual inspection. Then, if the investigation area is too large for effective and efficient application of

[1] http://www.devb.gov.hk/filemanager/en/content_29/CoP_MMW.pdf

acoustic/leak noise detection, they should plan and carry out step tests to divide the area into manageable parts for such application to pinpoint the leaks. The step tests and acoustic/leak noise detection are briefly described below:

(A) Visual inspection

The following critical features should be inspected to check the presence of water leaks:

- Exposed water pipes;
- Overflow / warning pipes of sump / roof tanks;
- Water pumps, and pump house if any;
- Road surface;
- Water control valve chambers/pits; and
- Drainage manholes

Signs of leakage can be easily identified from exposed water pipes. The float operating valve at the sump/roof tank may be jammed with sediments and may become out-of-order, letting water to be pumped in without stopping. Excess water would then be overflown through the overflow/warning pipes installed at the tanks. It is also important to keep these overflow/warning pipes clear.

When inspecting the road surface, look for any ponding in dry days which may be a sign of underground leakage. A quick field test can be conducted to verify the sources of the seepage. Since the potable water contain certain amount of residual chlorine, the tablet of DPD No.1 (N,N-diethyl-p-phenylenediamine) can be used to verify the free chlorine content retained in the ponding water if any.

For the valve chambers/pits or drainage manhole, they should first be uncovered. If the valve chambers/pits are flooded, or constant and persistent outflow of clean water is found inside the drainage manholes in dry days, there is sign of leakage from buried water pipes. Same as above, the tablet of DPD No.1 can be applied to verify the source of the water.

Photo 1 Continuous discharge of fresh water with chlorine

Photo 2 Valve pits flooded

(B) Step tests

Step test involves bracketing the test area with excessive leakage into a tight branched network with a flow meter installed on its input main.

Working from the valve furthest away from the flow meter, the size of the area is systematically reduced by closing valves to cut off different pipe sections in succession (so that less and less of the test area is supplied through the meter), at the same time recording changes in flow rate at the meter and comparing with model results.

The sequence of closing valves is followed by working backward towards the flow meter until the meter is reached (when the flow becomes zero). A disproportionate change in flow discrepancy between two successive steps indicates a leak in the section of pipe that was last shut off. The sequence is repeated by opening valves in reverse order. The method can effectively narrow down leaks to specific pipe segments of the distribution system.

It is normally carried out at night when the flow is at a minimum when leakage has the biggest share that we can use step test to allocate the leakage flow to different segments within the housing estate.

(C) Acoustic /Leak noise detection

Acoustic/Leak noise detection is to listen for water leaks when there is no obvious evidence, like water flowing on the street. Every hydrant, valve, and service line is a possible location to hear the sounds of water leaks. Since the sound travels on the pipe wall better than through the soil, one should always listen at the hydrants, valves, and pipe body first. As one gets closer to the leak, the sound gets louder.

Leak Noise Correlation (LNC) is one of the methods to pinpoint the leak spot in pressurized water main. Typically, microphones

or acoustic sound sensors are placed in contact with the pipe, at two or more points, to record the sound emitted by a leak somewhere between the points. The sound data is processed through a mathematical algorithm which compares or correlates the two recordings to determine the difference in the times it takes noise to travel from the site of the leak to each of the sensors. If the distance between the sensors is known in advance, this timing information can be used to determine the location of the leak.

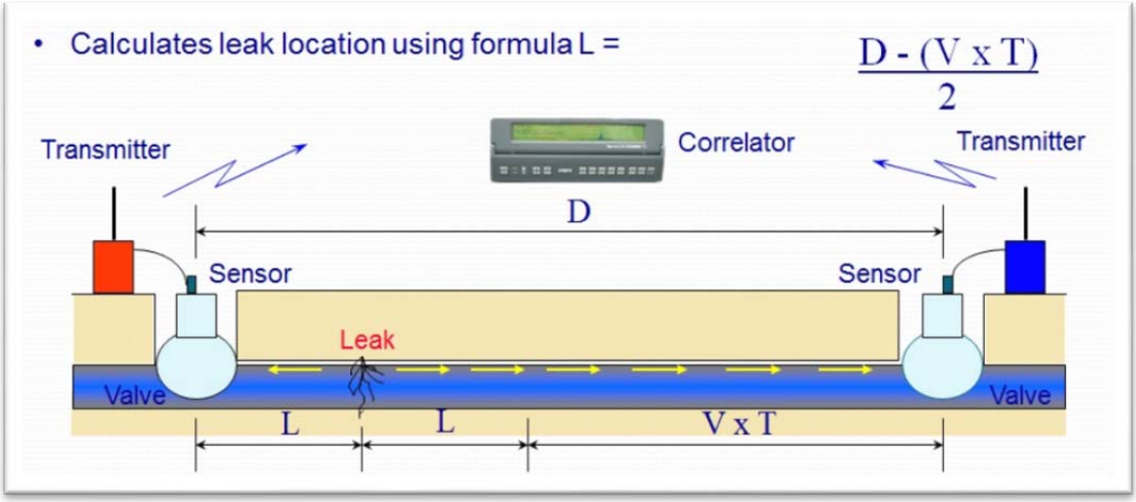

Figure 2 Simplified arrangement for leak noise detection

Photo 3 Equipment for leak noise detection

7. ENGAGING A LEAK DETECTION SPECIALIST

RA is recommended to engage a specialist in pinpointing the hidden leak spots. These specialists should be professionals with knowledge, and equipped with dedicated equipment in detecting water leakage from non-exposed pipes. They usually need to work at night time when leak detection by leak noise would be least influenced by the surrounding noises. They should be able to pin point the leak locations by their experience and professional judgement. A model specification on leak detection is attached at **Appendix A** for reference.

A reference list of the local service providers which have provided WSD with leak detection service under WSD's contracts can be obtained under the section "Tackling Leakage in Communal Service in Housing Estates" in the following WSD webpage:

http://www.wsd.gov.hk/en/plumbing-engineering/maintenance-of-internal-plumbing/registered-agents/index.html

Technical information about leak detection can be obtained from a number of organisations e.g. the Hong Kong Institute of Utility Surveyors at its web site (http://www.hkius.org.hk).

8. REPAIR OR REPLACEMENT WORKS

Once leaking spots are identified, RA should repair the leaking section(s) as quick as possible. In case the section of water pipe is seriously deteriorated, the whole section of water pipe should be considered to be replaced.

9. VERIFICATION OF REDUCTION IN WATER LOSS

After repairing or replacing the leaking pipes, RA should keep monitor the situation whether there is a significant drop of the discrepancy as mentioned in Section 4 above. If there is no obvious or significant drop of the discrepancy, there may be another leaking spots not yet identified. Steps in Section 6 need to be repeated to pinpoint another leak.

10. TECHNICAL ENQUIRY

RA may contact our Water Loss Management Section at telephone no. 2829 4440 for technical enquiries.

11. REFERENCES

Waterworks Ordinance (Chapter 102)

Waterworks Regulation (Chapter 102A)

HKSARG (2006) *Code of Practice on Monitoring and Maintenance of Water-Carrying Services Affecting Slopes*, Environment, Transport and Works Bureau, Hong Kong. (http://www.devb.gov.hk/filemanager/en/content_29/CoP_MMW.pdf)

12. APPENDIX A – MODEL SPECIFICATIONS OF LEAK DETECTION

A. EQUIPMENT SPECIFICATION

Equipment for Step Test

The minimum equipment to be provided by the Specialist for the step test shall include, but not be limited to, the following items.

(1) Flowmeter
(2) Data Logger

Equipment for Acoustic Leak Detection

The minimum equipment to be provided by the Specialist for the Leak Detection Survey shall include, but not be limited to, the following items.

(1) Leak Noise Correlator (LNC)

(a) LNC is a leak location instrument. It shall consist of at least two accelerometer sensors, two hydrophones, and a Correlator. The accelerometer sensors are attached to the contact points or valve spindles while the hydrophones are attached to the hydrants along the water main to be surveyed. The Correlator analyses the leak noises collected by the two accelerometer sensors or the two hydrophones for locating the leak position.

(b) The LNC shall have, but not be limited to, the following functions and capabilities:

- Survey distance of not less than 1000 metres.
- Capable of measuring a minimum of 4 different combinations of pipe diameters and pipe materials in a single measurement.
- Radio transmission, maximum at 500 to 1000 metres.
- Accuracy of measurement shall be within ±0.5 metre.
- Frequency interval for both cable and radio is 5 to 4000 Hz.
- The LNC allows the operator to change and select different settings (such as pipe materials, pipe diameters, filter ranges and frequency bands) and modes (such as survey mode, leakage detection mode and compute

mode).

- Display shall be high contrast Liquid Crystal Display (LCD) with display light or Light Emitting Diode (LED) and control panel shall be a watertight membrane keyboard.
- Power supply using rechargeable or alkaline batteries for a minimum of 8 hours operating time and provided with a 220 V battery charger.
- The accelerometer sensors shall be able to detect sound through pipe or valves and fittings and the hydrophones shall be able to detect sound/leaks from the hydrants through the water inside.
- The Correlator shall have data storage and print-out functions to record down the survey inputs and results.

(c) An annual calibration of the LNC shall be carried out.

(2) Mechanical Leak Detectors (MLD)

(a) MLD is a passive device similar to doctor's stethoscope which transfers the leak noise to the operator's ear directly through ground microphones.

(3) Electronic Leak Detector (ELD)

(a) The ELD shall consist of a ground microphone, a noise amplifier, headphones and frequency filters. The leak noise is amplified and transmitted to either headphones, loudspeaker or indicating meter electronically. Unwanted noises can be removed by electronic frequency filters.

(b) The ELD shall have, but not be limited to, the following functions and capabilities:

- The selectable frequency shall cover the range of 100 to 3000 Hz for filtering other noises.
- A LCD indicator or screen shall be included for digital data readout or leak noise level display.
- Power supply shall be provided by rechargeable and alkaline batteries for a minimum of 8 hours operation. The charger for the rechargeable batteries shall be 220 V.

B. PROCEDURES FOR LEAK DETECTION

Sounding and Visual Inspection

(1) The Specialist should carry out the following activities for the Sounding and Visual Inspection.

(a) Checking valve position

(b) Locating of the buried water mains by pipe locators.

(c) Visual inspection along the water mains.

(d) Visual inspection of all relevant valves and valve pits/chambers along the water mains.

(e) Sounding on all relevant valves.

(f) Visual inspection of utility manholes/pits along the water mains and on the slopes in the vicinity of the water mains.

(g) Test on any seepage water found on site.

(2) Checking Valve Position

The Specialist should obtain the latest copy of the relevant Mains Record Plans from the RA of the premises and check the position of each valve relevant to the leak detection work. The Specialist should make necessary arrangement and coordination (such as removal of rubbish) to ensure there is free access to the valve. In case of illegal structures or permanently parked vehicles on the valve cover, the Specialist should report and seek further instruction from the RA.

(3) Inspecting Valve Pit

The Specialist should open and inspect the valve pit covers of the relevant valves during the leak detection work. The Specialist should record any defects identified.

(4) Checking the Packing Gland

The Specialist should record any leak observed at a valve packing gland.

(5) For sounding on a valve, the Specialist should use the stethoscopes or ground microphones to listen the underground sound directly and perform the visual inspection.

(6) After carrying out the Sounding and Visual Inspection, the Specialist should complete and submit the Sounding and Visual Inspection Report and Valve Leak Inspection Record to the RA for their arrangement of repair works.

Step Test

Step test involves bracketing the test area with excessive leakage into a tightly branched network with a flow meter installed on its input main.

Working from the valve furthest away from the flow meter, the size of the area is systematically reduced by closing valves to cut off different pipe sections in succession (so that less and less of the test area is supplied through the meter), at the same time recording changes in flow rate at the meter and comparing with model results.

The sequence of closing valves is followed by working backward towards the flow meter until the meter is reached (when the flow becomes zero). A disproportionate change in flow discrepancy between two successive steps indicates a leak in the section of pipe that was last shut off. The sequence is repeated by opening valves in reverse order. The method can effectively narrow down leaks to specific pipe segments of the distribution system.

It is normally carried out at night before the morning high demand to minimize supply interruption and inconvenience to customers.

Acoustic Leak Detection by Leak Noise Correlator

The Specialist should carry out the following activities for the Leak Noise Correlator (LNC) Survey.

(1) Set up the LNC.

(2) Place the sensors on the pipe fittings such as valves or air valves. Mark the locations of the sensors on the mains record plan.

(3) Measure the length of the pipe between the sensors to be surveyed.

(4) Start the Leak Noise Correlator to collect data.

(5) Analyze the data.

(6) If suspected leakage is indicated by the Leak Noise Correlator, the suspected leakage location shall be marked on site with paint.

(8) Print out the Leak Noise Correlation result.

(9) Complete the LNC Survey Record and submit it together with the print-out of the Leak Noise Correlation result.