

UNITED WATER LEAK DETECTION SERVICE

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ABSTRACT

This paper details information on United Water's recently developed leak detection service, the aim of which is to detect and locate leaks on water mains in South Australia. It incorporates a systematic approach to investigate water leakage from the water network that would not otherwise present at the surface. Topics covered in this paper include:

- Why a leak detection program is of benefit to the asset owner;
- Information on leak detection equipment selected;
- The leak detection program in metropolitan Adelaide; and
- Future improvements in minimising water wastage.

1. BACKGROUND

Since 1996, United Water has been contracted to the South Australian Water Corporation (SA Water) to maintain and operate Adelaide's water and wastewater networks. In consultation with SA Water it was identified that both SA Water and United Water needed to do as much as possible to minimise water wastage in the network, particularly with state and national emphasis on water conservation and an ever growing public awareness of water scarcity.

It was this thought process that led to initial talks about the setting up of a systematic approach of investigating potential leakage within the water networks in metropolitan Adelaide. It was determined that a leak detection program would be the best way to interrogate the water networks and identify leakage. The leak detection program commenced in Adelaide on 20 February 2007.

2. WHY ESTABLISH A LEAK DETECTION PROGRAM

Although Non Revenue Water in South Australia is not considered a major problem, particularly against industry standards, any wastage of such a critical asset needs to be monitored with the intention of minimising any loss. It is also necessary as responsible corporate identities that both SA Water and United Water put in place a program to identify any loss within the system given the scrutiny of water conservation in the wider community. In addition to the environmental benefit there is also an economic benefit of potential water savings which needs to be offset against the cost of repairs. It is also anticipated the leak detection program will assist with asset management strategies.

3. UNITED WATER LEAK DETECTION OPERATION

United Water is currently running a one man operation for its leak detection program, it was identified early that the person for this job needed to be a self starter who could work autonomously. The program was always going to need to be a mobile operation and thus all equipment has been installed in a van. The internal fit out was designed around our operational needs and needed to be as user friendly as possible utilising the latest technology. All logging equipment has the ability to be connected to the lap top work station in the van. Analysis of all data can therefore take place in the field while the United Water operative is on site.

Equipment purchased

- Phocus2 Acoustic Logging System
- Primayer Enigma Loggers
- AS610 Digital Correlator
- Aquascope Digital Acoustic Ground Microphone
- Digital Listening Stick
- Laptop computer

4. SELECTION OF LEAK DETECTION AREAS

United Water's Assets Group in consultation with SA Water is attempting to identify suburbs where the presence of specific factors such as pipe age, static pressure and pipe material make it more likely to have higher leakage rates, when combined with certain soil characteristics these leaks may not present at the surface. Examples of these are sandy soils which can be found in seaside suburbs, areas that have a high burst rate, areas that have highly reactive soils, age of pipe work and different pipe materials. As the program is still in its initial start up period United Water's Assets Group are still analysing information gathered to see if there is a trend that might lead to identification of area that are more prone to having leaks that do not come to the surface.

5. PHOCUS2 ACOUSTIC LOGGING SYSTEM

The Phocus2 logging system was chosen as the preferred method of identifying leaks, this system revolves around identifying continual noise that the logger relates back to a potential leak. The technology built into this equipment enable the loggers to be programmed to listen at preset times, usually in the period midnight to 03:00hrs (quieter, low water use times). The loggers run for a 2 hour period measured in 1 second intervals and present information segmented into 5 minutes grabs, data is displayed in both tabular and graphical form. The noise data is analysed in terms of Critical, Peak and Spread as defined below.

- Critical is the lowest noise level which is present for over 99% of the logging time. This is the most important parameter because it indicates a continual noise not random noise such as traffic; this noise is generally caused by the continual noise of a leak.
- Peak is the noise loudness measured in db, the higher the level the closer the logger is to the potential leak
- Spread is a range of noise that can be represented in graph form and can be varied. What is looked for is a narrow symmetrical spread which indicates a leak; typically the spread would be less than 10db. A wider non symmetrical shape tends to indicate that no leak is present.

Counts are another area to scrutinise in investigating a leak. Counts are the number of 1 second measurements of noise levels. The higher the number of counts the more consistent the measured noise and the more likely the noise is caused by a leak. Counts are primarily used for the loggers to calculate a "leakage confidence factor".

A leak confidence factor provides an indication of whether the noise recorded by a logger is caused by leakage. It is an estimate for guidance and is not intended to substitute the operator's interpretation of the logger results in graphical format.

For the Phocus2 loggers leakage confidence factor definitions are as follows

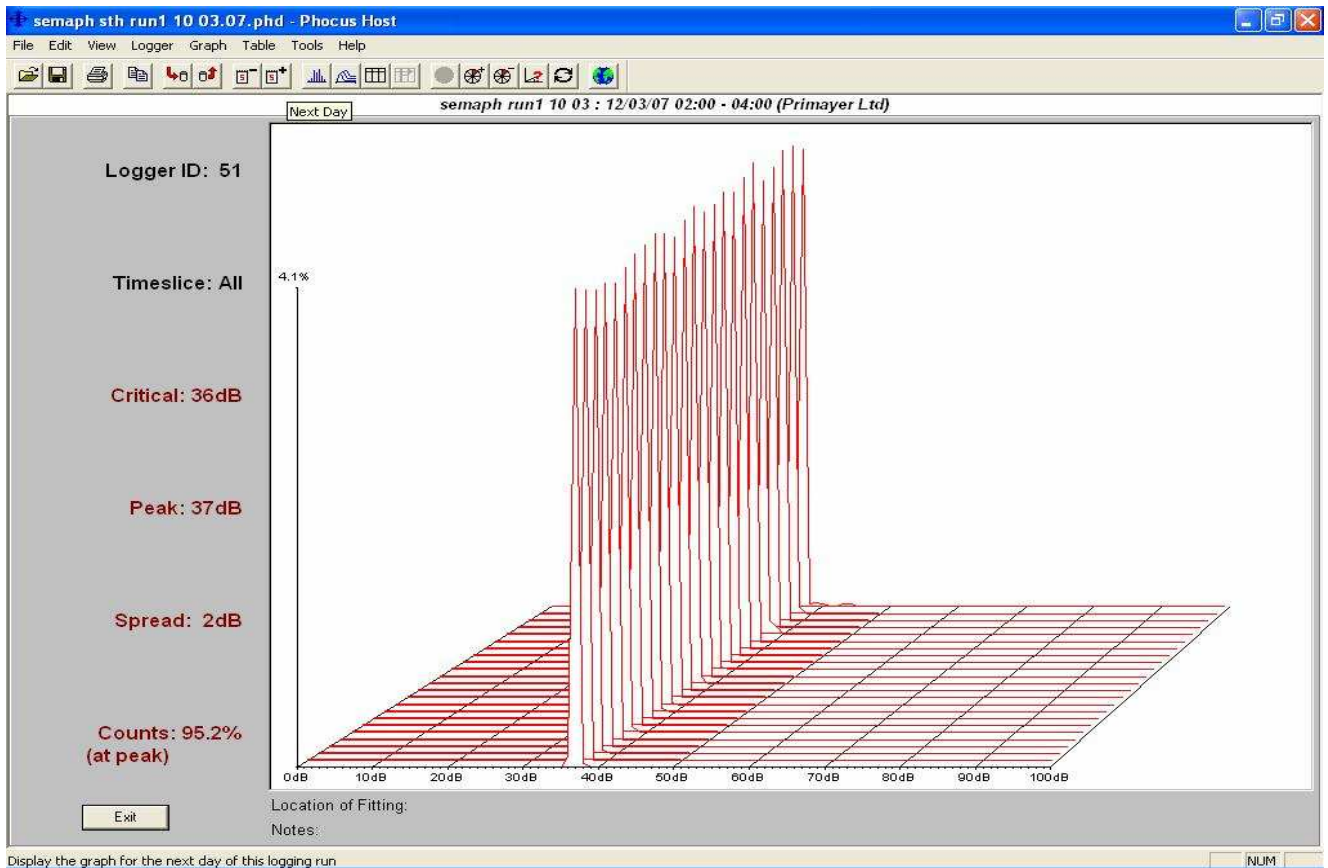
- 4 – Leak noise very confident
- 3 – Leak noise confident
- 2 – Possible leak noise plus other noise
- 1 – Not leak noise

All potential leaks graphs are manually scrutinised by the operator to identify if further investigation is required.

Figure 1 – Tabular display of leak detected by Phocus2 logger Robin Rd, Semaphore South.

Metering Area	Supply Area	Order of Log	Logger ID	Location of Fitting	Fitting Type	Pipe Material	Pipe Diameter	Notes	Leak Confidence	Critical (dB)	Peak (dB)	Spread (dB)	Counts at Peak
		14	51						4	37	37	2	93
		17	54						3	42	43	16	38
		20	57						2	41	43	25	31
		22	59						2	23	24	31	32
		12	49						2	21	22	6	77
		10	47						2	21	22	11	32
		1	38						2	20	22	32	35
		5	42						2	20	22	15	32
		2	39						2	19	21	26	41
		9	46						2	19	20	33	28
		6	43						2	18	20	9	31
		15	52						2	18	19	16	49
		19	56						1	39	43	13	29
		13	50						1	38	41	12	24
		18	55						1	33	38	7	31
		23	60						1	24	27	9	19
		21	58						1	23	26	17	29
		16	53						1	21	24	9	27
		4	41						1	21	23	29	35
		11	48						1	19	21	17	26
		7	44						1	19	21	8	38
		8	45						1	19	20	37	12
		3	40						1	14	15	25	33

Figure 2 – Graphical display of leak detected by Phocus2 logger Robin Rd, Semaphore South.



6. NEXT STEP FOR POTENTIAL LEAKS

Once a potential leak has been identified a second conformation of the leak is required before a dig up is started. With the purchase of additional leak detection equipment a secondary confirmation and or plotting of the potential leak is required, the methods used in this part of the investigation are as follows.

- A listening stick, is used to quickly check the immediate area close to the loggers that have identified a potential leak. The listening stick is used by listening to noise on exposed infrastructure e.g. water meters, fire plugs, if for example the leak can be heard on a water meter the leak search area will be narrowed down to the service coming off the main to the house holder internal pipe work. If identified as a leak on the SA Water side then a dig up will be organised to repair.
- A ground microphone, is used to search for leaks that have been identified as not being on the service where a listening stick can be utilised. The ground microphone picks up noise generated by the leak (usually on the main) and can be heard through the ground by this sensitive device. Traffic and other non related noise need to be very low as they impact on the ground microphone's ability to pick up leak noise.
- A digital correlator, can be used as a device that can narrow down a search area. The correlator has 2 transmitters that when put onto fire plugs or valves in the identified area transmit back to the receiver a correlation in meters on where the leak is located. The correlator presents a graph that can show the likelihood of what it is hearing is in fact a leak, as with the loggers a symmetrical peak. The distance between the transmitter and pipe size and material is put into the correlator and the correlator will come up with a

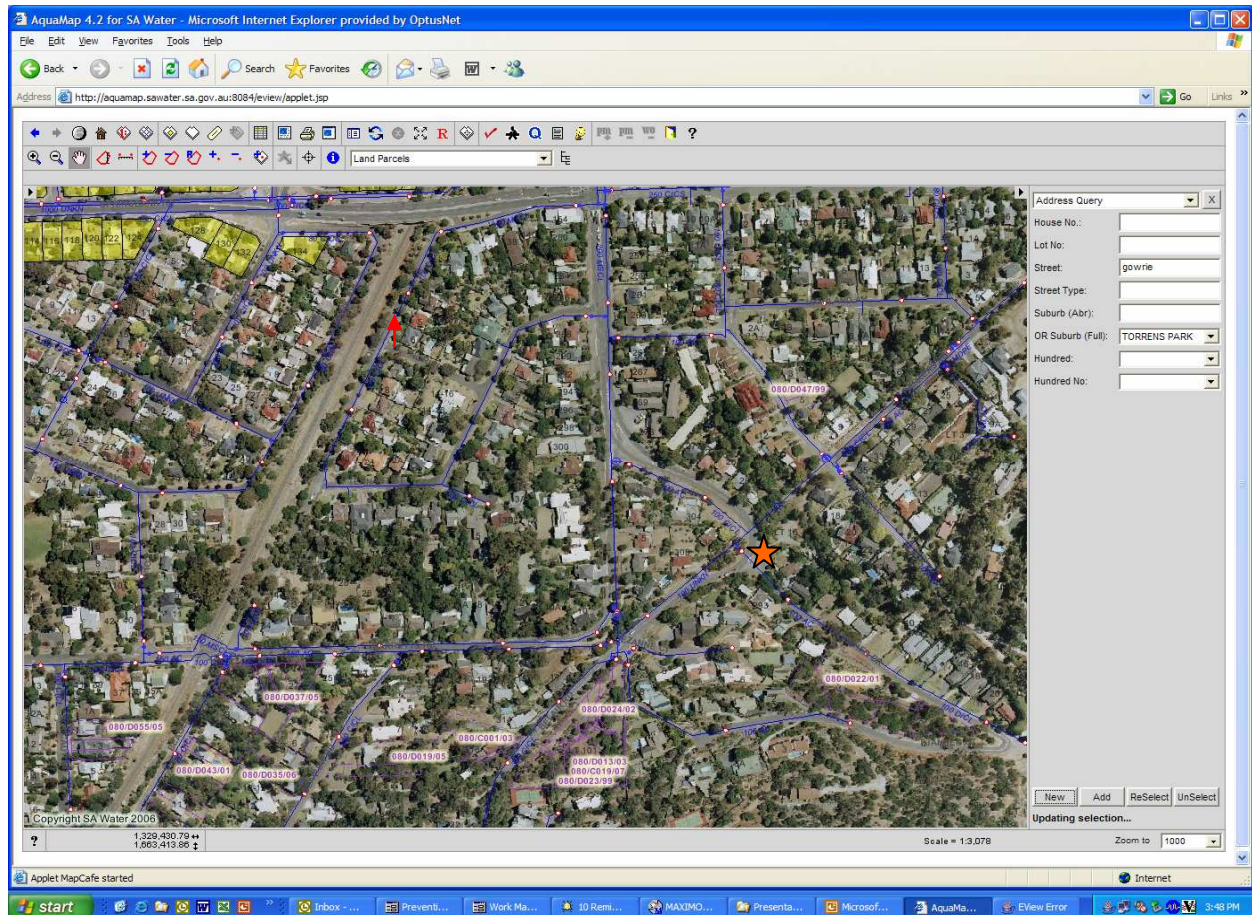
meterage of where it has pin pointed a leak. If the correlator has identified a position then a dig up is generated to find and repair the problem.

- Primayer Enigma loggers, these loggers have potentially the best technology of all equipment purchased, the Enigmas can record actual noise, this has been utilised in the past to identify usage noise which the Phocus2 loggers will pick up as a continual noise. The Enigmas can also be programmed to start in the middle of the night for areas such as the city, high traffic areas such as main roads, this can be the only time an accurate measurement can take place. The Enigmas take a one minute grab of actual noise every hour over a 2 hour period e.g. 1:00am, 2:00am, 3:00am inclusive. This one minute grab of noise can be replayed by the operator and reviewed as a means of being able to identify the noise source e.g. leak, meter, skeeting valve, pump operation. The Enigmas can be programmed to be used at any time of day and can correlate the leak as well. The Enigmas can also be put out over larger distances which can be helpful for larger diameter water main which have larger gaps between fire plugs and valves.

7. SOME EXAMPLES OF LEAKS FOUND

- In what was one of the first areas surveyed as part of the leak detection program a leak was first identified by the Phocus2 loggers and verified with the Enigma loggers. The leak was not coming to the surface and was found once excavated on a 32mm copper service feeding a reserve in Robin Rd, Semaphore South. Semaphore and its surrounding suburbs were identified as potential areas where leaks may not come to the surface given the sandy soils in the area. As with all leaks an estimate is done on the leak and is generally measured in litres per minute, this leak was estimated at 15 L/min with an annual loss calculated at 7.88 ML.
- Another example of leakage found was at Gowrie St Torrens Park, this leak was detected next to the railway line that runs through Torrens Park and its source could not be identified by a conventional analogue correlator and several digups. This leak presented major safety concerns given the water had the potential to affect the sub base of the railway line. Leak detection equipment was put out through Torrens Park and it was identified as a leak 410m away that was running underground and showing up near the railway track. This leak was coming from a old cut off water service and was estimated at 20 L/min with an annual loss of 10.51 ML.

Figure 3 - Gowrie St, Torrens Park (CICL or AC 100mm main) leak location denoted by the star, water flowing at the arrow.



8. CHALLENGES ENCOUNTERED IN ASSESSING RESULTS

As with almost every new technology or operation initiated certain challenges arise that from time to time can test your ability to successfully complete your tasks. This operation is no different with information coming from the loggers that have been hard to decipher. Some of the challenges have been things like sketting lock valves, essentially a valve that should be in the closed position but is not fully closed allowing water to pass, this noise is very similar to a leak noise and all the equipment will pick it up as a leak.

Stray electrical current, this also makes a constant noise which all the loggers will identify as a leak, the Enigma because they can record noise will help the operator identify a different sound to a water leak. With water restrictions in place some householders water during the night to avoid detection; if they are watering at a consistent rate during the period of analysis the Phocus2 loggers will interpret this as a leak. Secondary investigation with any of the other equipment will detect the sound has gone which we will then relate back to usage. Even properties with bores can generate constant noise in their internal pipe work that the loggers will identify as a potential leak. But given challenges faced so far the equipment United Water have and the operational

expertise our operatives are gathering, difficult scenarios are not impacting to any great degree on the ability of the ongoing surveys of the program and no dry holes dug to date.

9. CONCLUSION

With total Non Revenue Water being approximately 7 – 8 %, and water leakage a smaller fraction again in metropolitan South Australia. Water loss through leakage is certainly not as high as in other parts of Australia however, the ongoing diligent nature of the leak detection program is of high priority for United Water and SA Water. With water restrictions in place and the ever increasing realisation that water is a valuable asset companies such as United Water have a morale obligation to do everything in its power to minimise wastage within the networks it manages. The leak detection program has been initially set up with a 4 year life span and given it is still in its infancy it is expected to reap more rewards in finding more leaks as the expertise gathered through continual analysing of information increases. United Water sees this as a work in progress and only expects better results in the future. With these better results the expectation is for more gains in reducing Non Revenue Water and presenting itself as a leader in this field. This program has also been identified as an area for further training opportunities within the company and an opportunity to up skill the workforce. As United Water moves forward with this program and with its continual improvement philosophy gains in identifying leakage problem is well within the company's capability.