WATER MAIN CLEANING – A NEW ERA

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ABSTRACT

This paper explores the thought that we in the water industry have overlooked our potable water networks for far too long and are now starting to feel the effects of up to two decades of neglect.

It will also outline the work undertaken in a five-week water main cleaning programme during July & August 2013 in the Southern Highlands of NSW.

1.0 INTRODUCTION

Wingecarribee Shire Council covers an area known as the Southern Highlands between Sydney and Canberra. The water infrastructure consists of three raw water dams (two WSC operated and one Sydney Catchment Authority (SCA) operated) three water treatment plants located in Glenquarry, Bundanoon & Berrima. These three water treatment plants distribute water to twenty eight reservoirs and onto our customers through approximately 700km of water main.

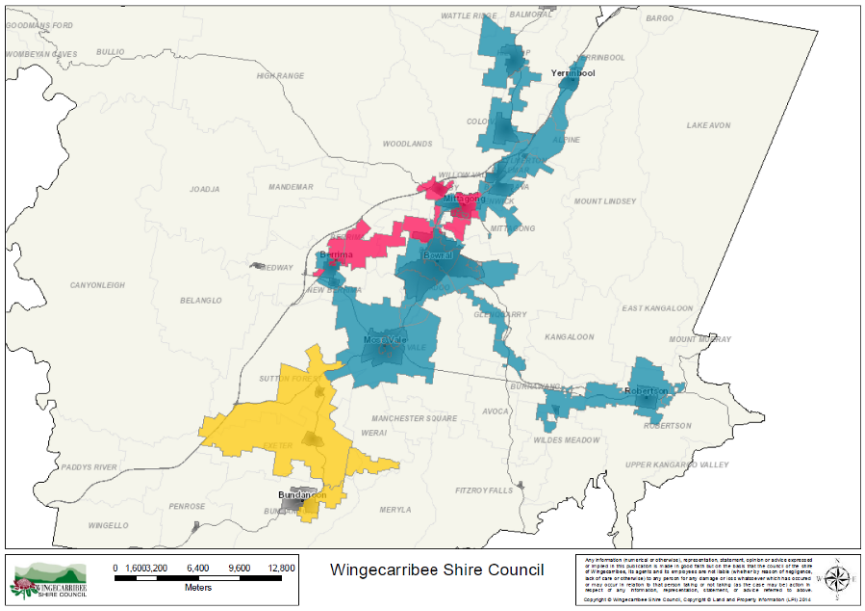

Figure 1: ***WSC Raw Water Supply Zones***

Over the last twenty years the water industry has seen many changes, these include tighter water quality requirements at treatment plants, privatisation of many global water utilities, smaller operating budgets and challenging regulatory performance monitoring. Many of these changes have conflicting priorities and one thing that seems to continually suffer is the acceptance that the water quality (in this case turbidity) can deteriorate once it leaves the treatment plant and enters the water network. In some cases it is not just a minor deterioration this can be up to twenty times 0.2NTU > 5.0NTU.

In my career I have had the opportunity to work for the UK's largest water utility where the drinking water compliance was of the highest standard however, the UK regulators still have a fairly relaxed limit for the drinking water network turbidity.

I have now had the opportunity to experience life on the other side of the world, with different regulations, standards & working practices. But one thing that is exactly the same in Australia is the acceptance that the water quality will deteriorate once it leaves the treatment plant. That on its own I don't have a real problem with, however it is the number of times that the works standard is multiplied that concerns me. The magnitude of this is now being understood and reacted to in small isolated pockets.

With this relaxed limit for turbidity in the potable water network a complacent culture has developed with a general reluctance to acknowledge when there is a problem to be solved. We are in many cases only carrying out maintenance of our water networks because we have a high volume of customer complaints. What ever happened to preventive maintenance? When it comes to water networks it seems to be all about reactive work. Over the last ten to twenty years proactive maintenance on our water networks has been sacrificed as either a cost cutting exercise or probably because there has not been the understanding of what will happen if we do nothing.

2.0 BACKGROUND

From the reporting year 08/09 – 09/10 WSC experienced an increase of 50% in customer contacts relating to discoloured water through its water supply network and the usual things were done to react to this situation. Flushing was the first however in many cases this only exacerbated the situation causing a wider spread issue. Checks of the water treatment plants were carried out and the customer contacts were plotted onto a water network map to see if any patterns were appearing. After some detailed investigations it was identified that the water network had reached a saturation point with sediments and deposits over a number of years. Therefore the water network only needed a slight increase in flow or a flow reversal and discoloured water was the result. Soon there was an acceptance that flushing was the only short term answer to be applied at very low flow rates.

2.1 INVESTIGATIONS

Investigations carried out were as follows:

- A look at the treatment plants was carried out to ensure that the water quality being distributed was within Australian Drinking Water Guidelines (ADWG) limits.
- Mains cut outs were inspected to determine levels of deposition within the water network
- Isolated key location flushing trials conducted to understand the scale of the problem (trunk mains, transfer mains, reticulation mains). This element returned the most concerning results, the whole system had a high level of deposition which was predominantly manganese (Mn).

Once we had determined that the route cause was the lack of proactive maintenance to keep on top of the background Mn that was oxidising in the network we had to develop a plan to recover the situation.

- What was the most appropriate cleaning method?
- What frequency was this maintenance to be carried out?
- How were we going to fund these activities?
- What could be done to ensure that the treatment plants were removing the Mn to optimum levels?

2.2 CLEANING METHODS

Flushing: by initiating high velocities of water through the water main, removing loose particles and debris deposited along the pipe wall it is only effective on water mains up to 150mm. This is due to an inability to achieve cleaning velocity in larger pipes and must be repeated at regular intervals to maintain a positive result. The other drawback of flushing is the large amount of water wasted during the process.

Air scouring, which involves blowing high pressure air mixed with small amounts of water through the main to increase sheer stress on the walls, was once considered to be the technology to move water main cleaning into the future. A number of Water Authorities have abandoned this technique, as it was found to be less cost effective and concerns were raised as to the potential for pipe damage. As with flushing, air scouring has been shown to be limited to smaller pipelines of size 375mm and below

Foam Pigging involves forcing several coated sponge objects (pigs) of various shape, density and roughness through the pipe so as to wipe or scrape loose material and bio-film from the pipe wall. Whilst this method has a high degree of success in cleaning water mains, it has a number of drawbacks. Pigs are unable to cope with large changes in pipe diameter and direction (i.e. tapers some in-line valves and bends). Furthermore, pigging involves a high setup cost and construction of a launcher and catcher assembly at each end of the targeted water main. Issues can arise in tracking the pig's location where junctions exist along the pipeline and sondes introduced to solve this problem are not always successful. Pigs will not survive intact on pipelines that have protruding service connections.

Ice Pigging a relatively new technique for cleaning drinking water pipes using slush ice. The technique, known as Ice Pigging was invented for use in the food industry but has shown to have numerous benefits that can now be effectively applied to drinking water networks. There are two major benefits that ice pigging brings, the first is the volume of water to be disposed of is a fraction of the other techniques. If flushing a main usually generates 3 to 4 pipe volumes of water, and sponge pigging generates 3 to 3.5 pipe volumes of water that needs to be disposed of, ice pigging with its 1.5 pipe volumes of water is an environmentally sustainable option with a fraction of the disposal costs and water loss. The second benefit is the ease in which the ice pig is inserted into and withdrawn from the pipe. It is simply inserted through a standard hydrant and removed through a second further along the pipeline.

Figure 2: ***Ice insertion***

Figure 3: ***Ice extraction***

2.3 REVIEW AND SELECTION

As a part of the selection process, I read all the relevant literature and technical papers relating to trials of Ice Pigging carried out across the world and recommended that we do not need to carry out our own trial we just needed to proceed with delivery of our preferred cleaning method. Our decision was easy when you consider the facts, so many benefits there must be a catch.

- Ice Pigging uses less water
- Its 1000 times more effective than flushing alone
- Its quicker.

2.4 THE COST?

Below is a cost comparison, which shows that Ice Pigging comes out very favourable in this area also. However, this will vary dependent on your frequency, I believe that each area should not need cleaning again for another eight years if your treatment plants are working to optimum (however, this would shorten all frequencies anyway).

Table 1: ***Cleaning Method Cost comparison (Based on 100mm dia main 1000m long)***

	Labour/Plant $	**Materials $**	**Cleaning Frequency**	**% Silt Removal**
Flushing Based on 30min per hydrant x 1 person	$233 **Total**	N/A **$ $233**	Every 6 months	30%
Sponge Pigging Based on 2 days labour x 3 people	$2592 **Total**	$3500 Launcher / catcher & sponge pigs **$6092**	Every 5 years	95%
Ice Pigging Based on 3 hours shutdown & ice pigging	$324 **Total**	$2000 **$2324**	Every 8 years	95%

Given the frequency differences the below shows a cost per annum of each method.

Flushing	**Sponge Pigging**	**Ice Pigging**
$466	$1218.40	$290.50

2.5 PROJECT DELIVERY

After detailed planning the start date was scheduled, we carried out a thorough system clean of Bundanoon & Exeter over a five-week period. We pigged the water supply zone in the system flow direction to ensure that an area that had been cleaned did not immediately get migrating sediments from an uncleaned section of the network. This took detailed planning and coordination but achieved a far higher quality finish. Each day 10 tonnes of ice was inserted into the mains at various locations and pushed through the network using system pressure. The progress of the ice was tracked by the flow analysis unit, which monitors flow, temperature and conductivity.

The number of insertions a day varied from 1-12 dependent on the pipe diameter and length of run. Customers were notified each day however many were not even aware that the water had been turned off as the cleaning duration was typically under 30 minutes.

The amounts of water main cleaned were:

- 48.6Km of 100mm
- 0.8Km of 125mm
- 2.2Km of 150mm
- 6.7Km of 250mm
- 14.3Km of 300mm
- In total 72.6Km of water main were cleaned in 113 insertions in 5 weeks.

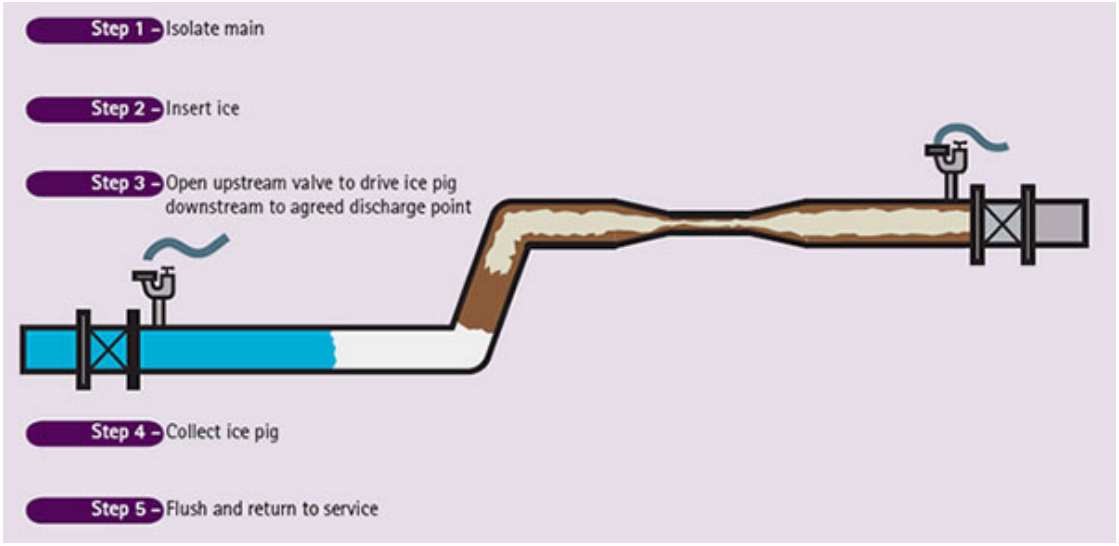

Figure 4: ***Ice Pigging Insertion Process***

3.0 CONCLUSION

- The Ice Pigging was carried out in Exeter & Bundanoon NSW - the first complete water catchment cleaning conducted using this method in Australia and the first two complete towns in the World. It has shown that Ice Pigging is a highly effective, straightforward no-dig technique that is faster, less disruptive, uses less water and is generally more cost effective than traditional swabbing / pigging techniques. When compared with water flushing the process is evidently more effective and uses approximately 50-75% less water.
- The only way to ensure that water quality is maintained once it leaves the water treatment plants is to ensure that we have proactive network maintenance.
- That water main cleaning should be carried out in a system flow approach i.e. source to tap.

Figure 5: ***Ice delivery Unit***

Figure 6: ***Ice Making Plant***

4.0 ACKNOWLEDGEMENTS

- The Council Ice Pigging Team – for embracing this new technology and persevering with the operational challenges during the project.
- Aqualogy Australia Project Team – for a project that was challenging, educational and fun.
- Graeme Berriman for the reference data used.

Figure 7: ***Ice Slush for the Pig***

Figure 8: ***Ice & Water samples during cleaning***