WHEN IS RESERVOIR CLEANING NOT JUST CLEANING?
FOLLOWING THE EVIDENCE TRAIL

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5th Annual WIOA NSW Water Industry Engineers & Operators Conference
Exhileracing Events Centre, Newcastle
29 to 31 March, 2011

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ABSTRACT

Asset owners and management have a duty of care to manage safety in its broadest sense. The consumers using a drinking water supply, the personnel operating the asset and the general public (if the structure fails), are all affected if management outcomes are poor. Regular cleaning of water storage reservoirs provides the ideal opportunity to conduct a simultaneous condition assessment process that can monitor the 'health' of an asset, and thereby ensure that all safety considerations are addressed. With the ability to assess a tank before, during and after the cleaning process, divers with condition assessment experience are able to identify a variety of indicators that produce an evidence trail to water contamination potentials, structural failures, and safety issues. This trail can assist in the planning of any future maintenance that may be required.

KEY WORDS

Reservoir inspection, Condition Assessment, Water Quality, OH&S, Structural issues, Evidence Gathering, Compliance Management.

1.0 INTRODUCTION

Drinking water storage tanks have four important areas of interest to management, all of which are safety driven – security, water quality, OH&S and structural. Regular cleaning should be more than just sediment removal - it is a time to assess the external and internal condition and to monitor the overall safety performance of the water storage. Diving within a tank offers unique opportunities to see what is happening in 'real time, and an experienced technician is able recognize evidence as it presents itself. Reporting this information back to the asset owner will allow the life expectancy and quality of service of the asset to be optimized. This paper will look at a number of key areas in the evidence gathering process.

2.0 DISCUSSION

2.1 First Impressions

The initial visual inspection can give a number of indications of issues that the storage may be experiencing. The construction materials and the age of the reservoir can point to failures already experienced by other clients. Evidence of graffiti and integrity of the compound area can indicate if security at the site is adequate. Witnessing small birds agitated and flying around a tank is often evidence that they are nesting inside the structure and potentially contaminating the water. Neighbouring vegetation larger than others adjacent to the tank can indicate that roots may have infiltrated the storage, and damp ground where conditions are normally dry usually indicates leakage. Also, the location of entry hatches, antennas and safety equipment is important information when preparing for any maintenance works on a water storage structure.

Figure 1: ***Birds nest inside overflow pipe***

Figure 2: ***Contamination exposure points***

2.2 Ventilation

It is important to match ventilation with the surrounding environment, and water quality should not be sacrificed for a longer roof framing life. Dust, debris and vermin ingress are all by-products of poorly designed or installed ventilation and the evidence is mostly inside the tank. If contamination events are occurring, then it is time to change the existing ventilation for something safer, even if it means replacing the roof structure every 30 years instead of every 50.

Figure 3: ***Ventilation debris***

Figure 4: ***Ventilation vandalised***

2.3 Sediment Patterns

The layers of sediment and the patterns they form can give an indication as to how the tank is being operated. Past performance of the water treatment process can often be observed in the types and quantity of sediments within the tank. Sediment patterns indicate water movement within the storage and this relates to the existing pipe work positions, both good and bad. Sediments on the walls indicate the tank is not cycling up and down sufficiently and a collection of sand around the inlet area may indicate a filter or bore casing failure.

Figure 5: ***Sand from Bore casing failure***

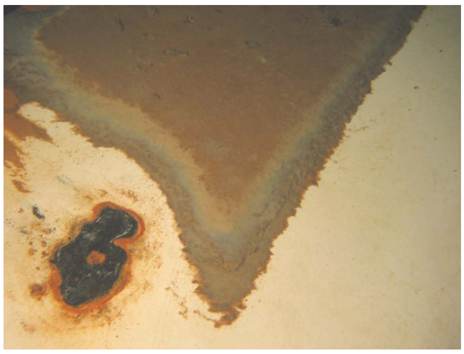


Figure 6: ***Sediment profile***

2.4 Pipe Work Configurations

All too often, there is evidence of pipes wrongly connected. Scours set up as outlets allow sediments to be drawn into the reticulation system. Top fill inlets often disturb the floor sediments and spray adjacent roof framing - this can lead to corrosion of the roof structure as well as aerating the water that promotes chlorine decay. Inlets facing the wrong direction either towards the outlet, parallel to the floor, or creating too much circumferential water movement can all have a detrimental effect on water quality. Outlets positioned too close to the floor allow sediment entry into the reticulation system, while redundant or unnecessary pipe work within the tank creates sediment traps, reduces natural water circulation and adds unnecessary corrosion product to the water disinfection demands. A visual inspection can also determine whether the incorrect pipes are being used to operate the tank, whether valves have been opened or closed without operator knowledge (inlets used as outlets and vice versa), or whether the correct material has been used for an application such as an internal overflow pipe.

Figure 7: ***Roof corrosion***

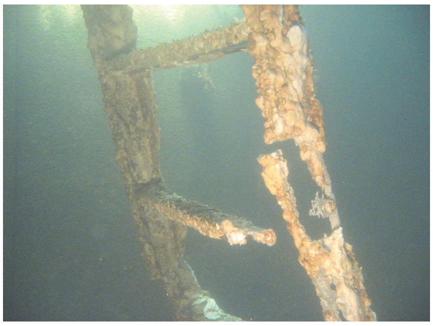
Figure 8: ***Collapsed Overflow pipes***

2.5 Cathodic Protection

Cathodic Protection (CP) is an essential application to prolong the design life of storages. While this process is generally supported by electrical testing and monitoring by reference electrodes, visual inspections can determine if it is really working as expected. An observation of key indicator points such as corrosion nodules on the floor and walls, support posts and around any 'difficult to coat' areas, can assist with the confirmation that corrosion has been either passivated or is still active. Sacrificial anodes should display signs of consumption, otherwise they are not connecting effectively with the areas they are meant to be protecting.

2.6 Protective Coatings

Areas that are more prone to coating breakdown include the floor, lower wall areas, support brackets, ladders, platforms and any galvanized materials within the storages. If these particular areas are in poor condition, water quality will be affected by contact with significant amounts of corrosion by-product. It is important to monitor coating performance and applicator ability (sometimes only obvious after years in service) to avoid repeating obvious problems in the future. A design life prediction of existing coatings based on time already run and deterioration noted to date can assist in budgeting both money and time for the next renovation project.



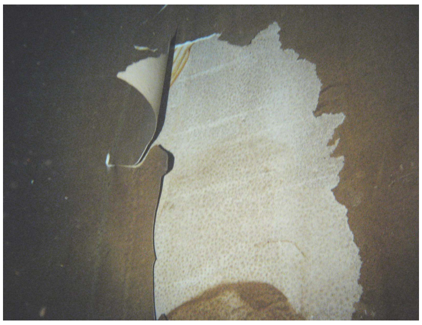


Figure 9: *Corroded ladder* **Figure 10:** *Coating failure*

2.7 Structural Issues

Upper wall deterioration can be identified by spalled concrete debris on the floor, caused by rafter connections or carbonation damage (a breakdown of concrete alkalinity). Rather than simply removing the debris, use it to identify where any problems may be occurring. Support posts can become weakened around the water line area by corrosion, causing roofing failures.

Figure 11: *Support bracket defective* **Figure 12:** *Concrete structure breakdown*

2.8 Roof Framing Conditions

Roof framing deterioration can be noted from corrosion debris dropped onto the floor (from rafters, purlins or safety mesh). Some roof framing is not suitable for warm, moist conditions (rolled zincalume purlins with unprotected raw edges) and it is important to identify what materials work in this 'under roof' environment and which ones are failing.
Roof framing and connections can be regularly submerged due to level sensors being set at the incorrect levels – this often occurs after a new roof is installed and existing water levels are continued.

Figure 13: *Roof structure corrosion* **Figure 14:** *Collapsed roof support from corrosion*

2.9 Drainage Design

Roof gutter collection points can mis-align with the internal drainage pipes or overflow risers, allowing external water to infiltrate the storage whenever there is a rainfall event. Likewise, unsealed hatches, platforms and leaking or overloaded roof gutters all allow contamination to enter the storage. These areas are best checked in wet weather conditions or by simply using a 'bucket of water splash test'. Infiltration areas can be observed within the tank by using an inflatable boat or by looking in and around the open hatch areas.

Figure 15: ***Mis-aligned internal drainage pipe***

Figure 16: ***Debris contained by non draining kick plate***

2.10 Leakage

Observations in 'real time' conditions (under actual working pressures) can identify many leaking areas not previously identified. Sediments missing in and around cracks or joints, subsided or softened seals and water flows detected by dye tracing, are all visible to an experienced diver - this opportunity would be lost if a manual drain and clean was performed.

Figure 17: ***Subsided floor seal***

Figure 18: ***Floor leak indicated by absence of sediment***

3.0 SUMMARY

This process is more than just cleaning a storage tank - it is a regular review and a 'health check' of the asset, conducted by experienced technicians. It is about observations from within the storage, and from a different perspective, where malfunctions and risks are identified, and the long term asset life and critical water quality are preserved. Safety should include the entire community using the asset and not be restricted to a few individuals who are involved in its operation.