SEND IN THE DRONE: IN-HOUSE AERIAL INFRASTRUCTURE INSPECTIONS

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ABSTRACT

Remotely operated vehicles (ROV) are increasingly being used by the Australian utility sector. Rapidly evolving technology means that ROVs are now easier to operate and more cost effective. North East Water has been operating an unmanned aerial vehicle, or drone to conduct aerial inspections of water and wastewater infrastructure since late 2013. The drone transmits live vision wirelessly to the operator and takes high quality photos and continuous high definition video. This allows for quick collection of more useful information that was previously not possible via traditional on-ground inspections.

Aerial inspections of water storages, reservoirs and catchments, water and wastewater treatment facilities and other infrastructure have been performed with excellent results. By entirely removing the operator from hazardous work situations, use of the drone has reduced health and safety risks and in particular, risks associated with working at heights and above water. However, the use of drones introduces new risks which must be considered and mitigated through safe work practices and procedures. This new technology also presents new challenges with privacy and aviation regulations developing alongside the evolution of drones.

KEY WORDS

Drone, ROV, Technology.

1.0 INTRODUCTION

Inspections of water and wastewater infrastructure are critical for monitoring and maintaining assets and the integrity of systems. Inspections have traditionally been carried out manually and can be time consuming and place operators at risk. Recent advances in remotely operated vehicle (ROV) technology have made alternative inspection tools available including pipe rovers, submersibles and unmanned aerial vehicles, or drones. North East Water has been using a drone to conduct aerial inspections of water and wastewater infrastructure.

North East Water's service region in north-east Victoria is 20,000 square kilometres and incorporates 37 towns, 15 raw water reservoirs, 23 water treatment plants, 80 clear water storage tanks and 18 wastewater treatment plants. The amount and variety of infrastructure as well as the geographical extent mean that a range of different time consuming inspections are required. Additionally, there are health and safety hazards associated with inspections including working at heights and near water.

These productivity and health and safety drivers prompted North East Water to trial the use of a drone in late 2013 for the primary purpose of inspecting clear water storages and water towers. The initial use of an inexpensive drone proved that the concept was an effective means to conduct aerial inspections. A higher quality, more powerful drone was then acquired as a tool for trial in routine inspections.

2.0 DISCUSSION

2.1 Technology Selection

The drone selection process was important to ensure that multiple operators were able to utilise the tool. As the operators of the drone were to be water industry operators and not expert drone pilots, the following selection criteria was required:

- Reasonably priced
- Ready to fly out of the box
- GPS flight stability for ease of operation
- Integrated drone and camera system for ease of operation
- Live streaming vision provided to the Operator
- High definition video recording for maximum detail
- Readily available spare parts and service within Australia.

North East Water purchased a quadcopter (four-bladed) drone that met these criteria and has proved to be reliable, easy to fly and provides excellent quality photos and videos. Figure 1 shows the drone in flight during a clear water storage inspection.

The drone has four electric motors and an on-board computer with GPS which allows for a flight time of up to 25 minutes. GPS is used to stabilise flight so the drone is able to hold its position with no input required from the operator. The drone can fly within an operating radius of 500 m and up to a regulated altitude of 120 m. The drone can be flown manually, or GPS waypoints can be programmed for automated flight, including take-off and landing. The drone is controlled via a conventional twin stick controller with an integrated mount for a smart phone. The camera mounted underneath the drone is operated via an app on the smart phone which provides live vision to the operator. The stable and predictable flight allows the operator to focus on framing and taking photos and video, rather than constantly focusing on the flight of the drone.

Due to the electronics on board the drone, it cannot be flown in rain. Whilst the drone uses GPS to stabilise flight, strong wind (approx. >20 km/h) can affect flight stability and reduce image quality.

Figure 1: ***North East Water's drone in flight during a clear water storage inspection.***

2.2 Clear Water Storage Inspections

Under the *Safe Drinking Water Act 2003* (Vic) all water storages used for drinking water must be inspected regularly. North East Water has 80 clear water storages of different age, size and design. Storages have traditionally been inspected manually by an operator through a visual check and climbing the storage to check roof, gutter and hatch condition as well as look for any signs of potential ingress or contamination. The use of the drone has reduced the need for operators to work at heights when climbing tanks and towers. The drone is also able to record images that an operator may not be able to see due to obstructions such as roof pitch, vents or solar panels. North East Water used the drone to inspect a clear water storage after a storm event in April 2014. Figure 2 shows a photo taken by an operator from the ground indicating a potential roofing issue (drone in background). The second photo in the sequence was taken by an operator from the top of the tank at the ladder access point. From this position no sign of damage can be seen. The final photo in the sequence is an aerial photo taken by the drone that shows the roof was in fact missing a section of flashing. The missing flashing was nowhere to be seen on the ground. The roof was able to be repaired the following day to minimise any potential water quality impacts.

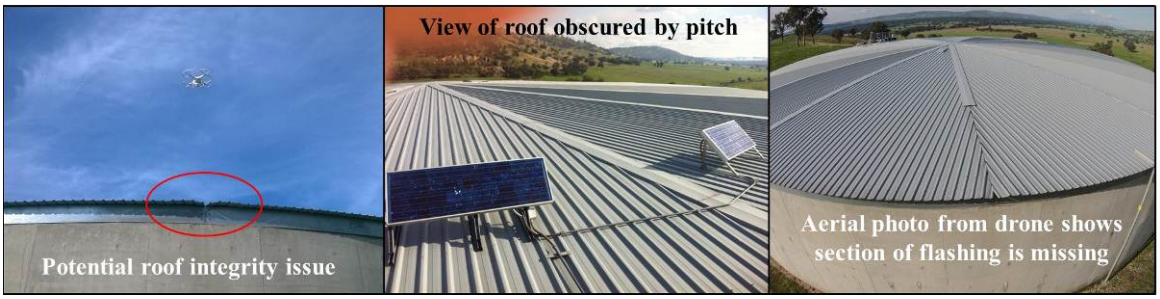

Figure 2: ***Photos taken from ground, roof and air of damaged clear water storage roof.***

2.3 Catchments, Dams and Reservoirs

In May 2014, a blue-green algae bloom occurred at Loombah Reservoir which is part of the water supply catchment for the town of Benalla. Due to access constraints, on ground observations only provided an indication of the magnitude of the bloom. The drone was used to take aerial photos of the reservoir which instantly provided the operator with the true extent of the bloom which was then used to inform monitoring and management decisions. Figure 3 shows an aerial photo taken by the drone of Loombah Reservoir with algae visible along the shoreline in the right of the photo.

Figure 3: ***Photo taken by drone at Loombah Reservoir, Benalla to determine the extent of a blue-green algae bloom.***

2.4 Wastewater Treatment Plants

North East Water has used the drone to conduct aerial site inspections of wastewater treatment plants. The drone can be flown from inlet structure through to outfall and capture the entire treatment process in-between. This information can prove useful for planning upgrades and troubleshooting treatment issues. A lagoon at Beechworth Wastewater Treatment Plant had recently been retrofitted with fixed media and diffuse aeration. In June 2014, the drone was used to inspect the distribution and uniformity of the aeration pattern which was not apparent from the ground (Figure 4).

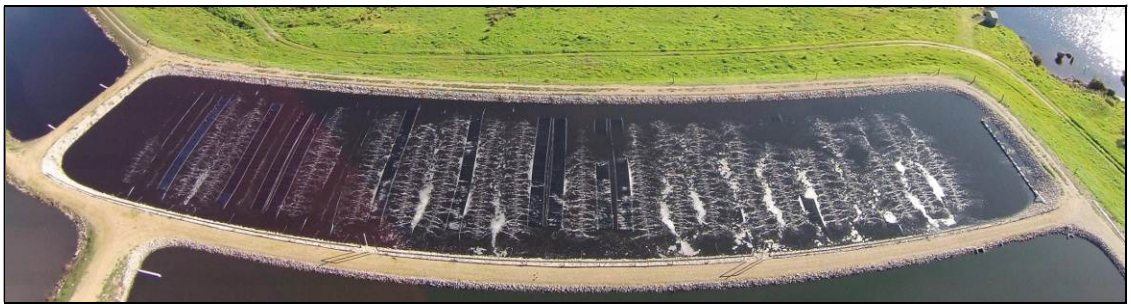

Figure 4: ***Photo taken by the drone of a wastewater lagoon showing diffuse aeration pattern.***

2.5 Other Applications

Other applications that North East Water has used the drone for, or considered include:

- Recording flow dynamics of wastewater treatment plants
- Recording progress of construction projects (Figure 5)
- Inspecting offtakes in reservoirs only accessible by boat
- Assessing and recording dam spillway and wall conditions
- Inspecting decommissioned infrastructure
- Providing high quality, current aerial photographs
- As an education tool

New applications for the drone are being devised as operators become more aware of its capabilities.

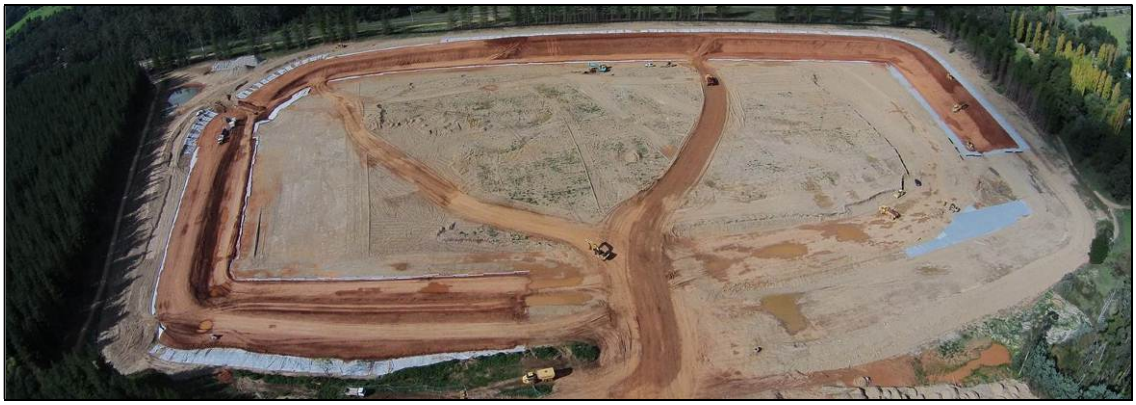

Figure 5: ***Photo taken by the drone of a 520 ML off-river water storage under construction at Bright.***

2.6 Health and Safety Considerations

Whilst the use of a drone has had clear health and safety benefits through reducing the need to work at heights and near water, this new technology also introduces its own hazards. When spinning, the blades of the drone pose a cutting risk to the operator. The drone weighs over 1 kg and can travel at speeds of up to 50 km/h which could cause injury to an operator or bystander if a collision was to occur. Despite the drone having built-in safety features that reduce the likelihood of these hazards occurring, North East Water has developed safety protocols and procedures. This includes a standard operating procedure, compulsory use of PPE and exclusion zones to mitigate hazards introduced by the drone. An internal training program has been developed to ensure that operators of the drone are competent. This includes operation and flight theory and operator training and assessment.

2.7 Regulation of Drones

Aviation and privacy regulation in Australia is fast developing to address the rapid growing use of drones. At present there are some grey areas and the regulation of drones could be considered to be open to interpretation as it tends to lag behind the advances in drone technology.

The use of drones in Australia is regulated by the Civil Aviation Safety Authority (CASA). Under the *Civil Aviation Safety Regulations 1998* an operator of a drone used for the purposes of 'air work' (i.e. aerial reconnaissance for a commercial use) must be licenced. Under the Regulations, a drone must only be flown under the following conditions:

- In uncontrolled airspace and not within 5.5 km of an airport or aerodrome
- At a maximum operating height of 121.92 m
- Under appropriate weather and daylight conditions
- Away from populous areas
- Within the pilot's line of site at all times.

The process to obtain a CASA licence to operate a drone can be relatively costly and time consuming. North East Water is currently investigating this process.

Privacy concerns are an aspect often associated with the use of drones. The *Information Privacy Act 2000* (Vic) is the key privacy legislation in Victoria. Under this Act, surveillance cannot be used to collect personal information about individuals and for the purpose of using or disclosing that information. North East Water has procedures in place to ensure that the use of the drone does not breach privacy law.

3.0 CONCLUSION

The use of ROV technology in the water industry is increasing as technology becomes more readily available and cheaper.

The use of a drone by North East Water has proven to be a cost effective and time efficient way of conducting safer and more informative inspections of infrastructure. The drone has proven to be safe, reliable and provides the operator with timely, high quality information that cannot be collected through traditional inspection methods.
Whilst the use of the drone does not entirely replace the need for on-ground inspections, it can potentially reduce their frequency and increase overall productivity.

The regulation of drones in Australia lags behind the developing pace of the technology, and it could be argued that current regulation is open to interpretation in some areas. This is a key area to watch as drone technology becomes increasingly popular in private and public sectors.

New uses for ROVs and drones are developing in parallel with the technology. The use of this technology is only likely to increase in the coming years which will provide the water industry with the opportunity to remain at the forefront of innovation and technology.

4.0 ACKNOWLEDGEMENTS

To North East Water's Operations staff for embracing this new technology and devising new uses for it.