

SEWER RADIATION MONITORING AND MANAGING POTENTIAL RISK TO STAFF



Paper Presented by:

Nicole Reid

Author:

Nicole Reid, *Water Management Officer,*

Orange City Council



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Nicole Reid, *Water Management Officer*, Orange City Council

ABSTRACT

A new hospital was being built in Orange through 2010 and discussions were raised regarding the requirement to install a decay holding tank for radioactive wastes potentially being discharged to sewer. This raised concerns with Orange City Council (Council) staff of the potential health risks of coming into close contact with the wastewater through working at the Orange Waste Water Treatment Plant (WWTP) or through the maintenance of reticulation downstream of the hospital discharge point.

The immediate response was to set up procedures including exclusion zones and restricted areas to limit access to areas of potential risk. Subsequent literature reviews and consultation with regulators and professionals in the industry, determined the risk to operators to be minimal.

To validate findings of the desk-top study, possible areas of risk were monitored through various programs around the WWTP and of the reticulation downstream of the existing hospital. Exposure levels for Council staff at the WWTP were found to be no different to background levels. Doses above background radiation levels were recorded within the sewer reticulation, although all locations monitored were below the legislated annual dose of <1000 microsieverts per annum ($\mu\text{Sv}/\text{annum}$) for the general public.

This presentation will discuss staff concerns, the processes that were conducted, and the outcomes of the process.

1.0 INTRODUCTION

Many hospitals and health care facilities conduct diagnostic and therapeutic treatments using radionuclides. The most common are diagnostic procedures using isotopes with half-lives of less than 48 hours (Kirkwood, 2010). However some facilities treat thyroid cancer with Iodine-131 which has a half-life of approximately eight days (World Nuclear Association, 2010). Thyroid treatment involves administering relatively high doses of Iodine-131 to patients, where they are isolated in hospital due to the radiation the person will potentially emit. Research conducted by Sydney Water and the University of NSW demonstrated that a large proportion of the isotope is discharged to sewer in the urine excreted by the patient (Cassels, 2008; Kirkwood, 2010).

Guidelines for the disposal of radioactive wastes to sewer were limited, with conditional liquid trade waste approvals requiring a discharger to comply with the *Radiation Control Act 1990* and *Radiation Control Regulation 2003*. Metropolitan water authorities generally take the precautionary approach and request health facilities to install decay holding tanks. This is feasible for new developments or redevelopments, but can be very expensive when trying to retrofit the holding tanks.

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and National Occupational Health and Safety Commission (NOHSC) (2002) established radiation protection standards that include:

- limit of exposure to 1,000 μSv per annum for the general public; and
- limit of exposure for radiation workers is not to exceed 20,000 μSv per annum averaged over 5 years.

Council adopted the general public criteria above as a conservative measure. In discussion with the NSW Environmental Protection Authority (EPA) and ARPANSA, the radiation protection standard for the general public of <1,000 μSv /annum may be received over any period of time within 12 months (e.g. over the year or over an hour). This is exposure above natural background radiation levels. The average Australian background radiation dose is approximately 2,000 μSv /annum (ARPANSA).

NB: 1,000 μSv = 1,000 microsieverts = 1 milliseivert = 1 **mSv**

The NSW State Government was in the process of constructing a new base hospital in Orange through 2010. During Council's Liquid Trade Waste (LTW) procedures for the new base hospital, the Area Health Service confirmed the existing base hospital did not have decay tanks installed for pre-treatment of Iodine-131. As the existing hospital was to be decommissioned in the short term, retrofitting a decay holding tank was not considered practical. It was also confirmed that the new base hospital would continue to take patients treated for thyroid carcinoma and the need for a decay holding tank at the new facility was being questioned.

Council's water and sewer staff were concerned as the risks were unclear and there was limited data available for the Orange circumstance. Each location can vary on the number and frequency of treatments as well as dilution within the reticulation system. A briefing note was commissioned by Council's liquid trade waste staff requesting background and direction on how to minimise potential contact and a monitoring approach. Other stakeholders that provided management advice included the NSW Office of Water, NSW Department of Health, Orange Base Hospital and the Orange branch of PRP Diagnostic Imaging.

2.0 DISCUSSION

As the risks were being questioned, a combination of administration, engineering controls and monitoring was conducted to eliminate risk and assess the potential for exposure.

2.1 Initial Response

Due to safety concerns from Council's water and sewer staff during the field investigation stage, restricted areas were set up immediately around the WWTP and an exclusion zone downstream of the hospital discharge point for the sewer maintenance crews (July 2010). Further, no work was to be scheduled for downstream of the hospital. If emergency works were to be required, staff were to delay works if possible and contact the hospital to confirm if a patient treated with Iodine-131 was admitted at the time.

The restricted area at the WWTP required staff and contractors to:

- limit contact with sewage;
- limit time spent in the restricted area;
- wear appropriate PPE; and
- maintain general cleanliness protocols as for contact with sewage.

A communications plan was established with the hospital so staff would know when a patient would be treated with Iodine-131 and admitted to hospital, which in the case for Orange is generally from Friday to Monday morning on a needs basis. The plan enabled staff to contact the hospital to confirm the last time a patient was admitted or if a patient is present at the time of a sewer call-out. Presently, the administering nurses contact staff via e-mail, providing a two day notification of the admission so staff can plan activities as required.

Monitoring was conducted at various locations of the WWTP on 26 June 2010 by PRP Diagnostic Imaging using a hand held monitor, Radiation Alert Inspector+. This is an instantaneous monitor and was used to provide an indication of potential exposure around the WWTP. There were 26 locations monitored, such as the inlet works and biosolids stockpile area. Measurements ranged from 0.107 to 0.197 $\mu\text{Sv/hr}$, and compared with background levels of 0.185 $\mu\text{Sv/hr}$ for the centre of Orange. The measurements taken on this day were consistent with normal and natural background radiation for the areas inspected.

Flow tests and dilution calculations were also conducted to calculate the time taken for wastewater to travel from the hospital to the WWTP. Conservative calculations predicted that each contaminated discharge from an Iodine-131 patient at the hospital would be diluted with a minimum of 40,000 L of sewerage at the point of entry to the WWTP.

2.2 Monitoring Program

Further monitoring was planned by Council due to timing and concerns from staff. The question was how to monitor exposure risks for the sewer staff and WWTP plant operators - how many locations were needed, what distance from the hospital should be monitored and did daily peaks need to be recorded? Monitoring required something secure, easy to install and could collect data without being manned.

Council chose Thermoluminescent Dosimeters (TLDs) to conduct monitoring within the sewer line downstream of the hospital and at a number of locations at the WWTP. These are standard radiation monitoring devices used by workers such as health professionals. The use of the TLDs is provided and monitored by Australian Radiation Services. The TLDs would capture the peaks, and would be included in the total for the monitoring period for total exposure, satisfying measurement requirements against Australian standards.

A monitoring program was set up with the TLDs initially for a period of two months at the various locations. Two areas were established, including the reticulation system downstream of the hospital (six sites) and the second being the WWTP (four sites). A control was assigned to each area. The TLDs used for this monitoring program were within water tight packaging and positioned as close as possible to the sewage. The TLDs were left in location 24 hours, seven days a week for the duration of the monitoring.

Two of the ten sites, being the two manholes in closest proximity to the hospital, reported emissions for the 56 days. There were four patients admitted to the hospital that had undergone thyroid carcinoma treatment during this period. Recorded emissions were well below the annual dose standards for the general public (the conservative limit adopted by Council) being 70 μSv and 10 μSv above background radiation levels recorded by the control. The eight other sites did not detect emissions, including the WWTP.

Following this monitoring it was recommended in October 2010 to remove the restricted area at the WWTP, whilst maintaining standard hygiene practices for dealing with sewage. The sewer maintenance exclusion zone was modified to a restricted area as a precautionary approach, as emissions detected were at low levels, and risk could be managed by avoiding the area when a patient was admitted through procedures.

2.3 The New Site

The NSW Office of Water (NOW) engaged an independent consultant (Australian Radiation Services, ARS) in October 2010 to investigate whether there was any undesirable exposure levels of Council workers to radioactive material due to discharge of waste from hospitals that conduct iodine-131 treatment. The study reviewed four different locations in regional NSW where there is discharge from patients administered with Iodine-131. An approval to discharge liquid trade waste was given to the new base hospital in Orange with concurrence from NOW in December 2010. The approval was interim pending outcomes of the investigation engaged by NOW as liquid trade waste conditions related to the therapy department may have been expanded or amended.

The new base hospital was opened in mid-March 2011. A new restricted area was established for sewer maintenance downstream of the new hospital, including directions for actions and a communication protocol. There were still concerns from water and sewer operators regarding the frequency of admissions and risks to staff as a delay holding tank was not yet installed at the new hospital.

Safety concerns were still raised regarding the access to the sewer downstream of the hospital as in the case of an overflow whilst a patient was admitted and where remedial works could not be delayed. For this purpose, a hand held instantaneous monitor was purchased to take readings in the field. This was also used when accessing sites for monitoring purposes and to gather more background data.

Although previous monitoring at the old hospital site indicated the risk was minimal, a new monitoring program was established for the new site being for a twelve month period, commencing November 2011. Installation and removal of TLDs was timed to be when there was no potential of radiation discharge. As with the initial monitoring, all locations monitored were below the legislated annual dose. There were 20 patients admitted to hospital for this monitoring period. No emissions were recorded at the WWTP, meaning exposure levels for Council staff at the WWTP are not different to background levels. Emissions were recorded within the reticulation downstream of the hospital with all sites being < 400 $\mu\text{Sv}/\text{annum}$, being below the legislated annual dose for the general public.

2.4 The Requirements

Following on from the NOW independent study, a circular applicable to all NSW non-metropolitan water utilities (LWU 12) in December 2011.

This circular was prepared in consultation with the NSW Radiation Advisory Council and

includes:

'The main conclusions of the study report are:

- *The estimated annual exposure dose to a worker at the sewerage treatment works due to the discharge of human waste from nuclear medicine facilities assessed in this study is not noticeably different to the expected annual natural background radiation level of 1.5 mSv per year.*
- *The estimated exposure doses for workers at the sewage treatment works are below the legislated annual dose of 1 (one) mSv per year for a member of the public.*
- *The estimated exposure doses for workers performing sewer maintenance work **immediately downstream** of a nuclear medicine facility (eg. At the boundary trap) are below the legislated annual dose of 1 (one) mSv per year for a member of the public. These estimates are based on the assumption that such maintenance work is carried out once per year over a period of 4 hours'*

The circular details the requirements for the Local Water Utility and a nuclear medicine facility using Iodine-131 for treatment of patients for thyroid disease. These requirements were detailed in Council's full liquid trade waste approval given to the base hospital in September 2011. This includes notification of the number of treatments to be reported to Council, and a requirement for the discharger to conduct a risk assessment if patient numbers significantly increase. There was no requirement from the findings of the study for Council to conduct any monitoring.

3.0 CONCLUSION

Although Iodine-131 risks for the Orange Base Hospital were apparently low, there was a concern from Council water and sewer staff due to the absence of a delay holding tank. The approach was to eliminate risk of exposure, obtain a better understanding of processes producing the potential risk, establish internal procedures, and conduct our own monitoring to validate assumptions.

The treatment processes are now better understood and internal procedures include relevant detail providing communication avenues if the sewage system needs to be accessed during scheduled or emergency works.

Monitoring, whilst not required by regulators, was beneficial at the time as it provided confidence for Council staff whilst investigations were being conducted.

Findings of the twelve month monitoring program were in line with the study engaged by NOW. Recommendations provided for inclusion into the liquid trade waste approval conditions are supported.

4.0 ACKNOWLEDGEMENTS

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5.0 REFERENCES

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