science summary

Environment Agency

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Radionuclide partitioning to sewage sludge (Part A) − Radionuclide discharges to sewer (Part B)

Summary SC020150/SS

The Environment Agency's tool for modelling radioactive discharges in sewage is fairly accurate but could be updated for a handful of radio-elements, according to two new reports, the second of which found that iodine-131 discharges from a London hospital would expose the public to only a few percent of the annual dose limit at the very most.

The reports were commissioned by the Environment Agency to investigate the effects of authorised discharges of liquid radioactive waste into the sewage system. The work was carried out by Enviros Consulting Ltd with support from WRc, the University of Plymouth, and the Radioecology Unit at the University of Liverpool.

The first study, *Radionuclide partitioning during sewage treatment – A laboratory investigation*, carried out experiments to generate sludge retention factors for a model used by the Environment Agency to assess the impact of these discharges on critical groups, such as sewage treatment workers and members of the public.

The study explored the solid-solution behaviour of a range of radio-elements: Br; Ca; Co; Cu; Fe; Ga; I; In; La; Mn; Ni; P; Re (as an analogue for Tc); S; Sr; Th; U; V; and Y. The elements were chosen for their relatively high radiological risk (based on the total amount discharged in the UK and the radiotoxicity of the isotopes) and the data available on their behaviour during sewage treatment.

Experiments were conducted using stable isotope tracers, specialist laboratory facilities and sewage materials sourced from a domestic housing estate. These assessed:

- partitioning processes likely to occur during transport through the sewer;
- the transfer of tracer to primary solids during primary settlement;
- the transfer of tracer to solids during secondary (activated sludge) treatment;
- the overall sludge retention factor, SRF, typical of a sewage works.

The study found good agreement between SRFs determined in the laboratory experiments and those set in the Environment Agency assessment tool for Br, Co, Fe, Ga, In, P, Re (as Tc), S, Th, U and V. However, for others agreement was less good, particularly for Ca, I, La, Mn, Sr and Y. For these elements, the report recommends updating the SRF values in the Environment Agency modelling tool.

The second report, *Radionuclide discharges to sewer - A field investigation,* was commissioned in response to an application for increased iodine-131 discharges from the Royal Marsden Hospital in London. Iodine-131 is used by the hospital to treat neuroblastoma (a childhood cancer of nerve cells) and thyroid cancer.

An initial assessment of the application showed that doses could exceed 0.3 mSv per year. It also showed that people might be exposed to iodine-131 in the rivers and brooks receiving treated effluent from the nearby Hogsmill sewage treatment works.

Environment Agency guidelines state that if initial predictions show doses could be greater than 0.02 mSv per year, a more detailed assessment should be carried out. Thus, this study investigated iodine-131 activity concentrations in crude sewage, during sewage treatment, in sewage effluent and sludge cake and in river water and sediment around the Hogsmill sewage plant from discharges from the Royal Marsden Hospital.

Based on a total administration of 15 GBq of iodine-131 given to three hospital patients over three consecutive days, the study found activity concentrations of iodine-131 in:

- crude sewage of on average 26 Bq l^{-1}, reaching a maximum of 50 Bq l^{-1};
- treated effluent of on average 11 Bq l^{-1} and in all samples, less than 20 Bq l^{-1};
- primary settled sludge up to 76 Bq l^{-1}, in activated sludge up to 130 Bq l^{-1} and in dewatered sludge cake up to 1,800 Bq kg^{-1} (dry weight).
- river water up to 20 Bq l^{-1} and river sediment up to 67 Bq kg^{-1} (dry weight);
- intertidal sediment, where the Beverley Brook meets the Thames Estuary, up to 570 Bq kg^{-1} (dry weight).

Based on a survey of gamma dose in air, exposure at most points around the Hogsmill plant and along Beverley Brook was indistinguishable from background levels (19 nSv per hour). At the plant, slightly higher dose rates in air were measured (up to 31 nSv per hour) near to freshly dewatered sludge, representing about 10 nSv per hour above background.

Based on highly pessimistic exposure times (1,000 hours per year) exposure would still be minimal (0.01 mSv per year above background), around one per cent of the annual 'controllable' dose limit to a member of the public. Over intertidal sediments, exposure could also be higher, but again would be likely to be no more than a few percent of the annual dose limit.

Of the total radioactivity administered to patients at the hospital, most is excreted and enters the sewer system. This study showed that, of this, more than half is lost through decay or association with solids in the sewer, about two per cent is likely to be transferred to dewatered sludge cake at the Hogsmill works and about one third is likely to be discharged after treatment to the Hogsmill River and Beverley Brook.

These reports will be of interest to Environment Agency staff who use the organisation's Initial Assessment Tool to assess the radiological impact of discharges.

It will also be of interest to scientists and organisations who monitor radioactive and/or other discharges in the sewage system, or who work in or carry out research on sewage treatment.

This summary relates to information from Science Project SC020150 reported in detail in the following output(s):-

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