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FATE OF SODIUM MONOFLUROACETATE (1080) FOLLOWING DISPOSAL OF PEST BAIT TO A LANDFILL

Summary: The results of a programme to monitor the containment and natural breakdown of approximately 12 000 kg of toxic vertebrate pest bait, containing compound 1080 (sodium monofluroacetate), in a landfill site are reported. The baits were buried in a purpose-dug pit in a managed solid waste disposal site at Winton in central Southland, New Zealand, in August 1996. Compound 1080 is used extensively in a bait form to control a range of introduced vertebrate pests, (e.g., European rabbit, Australian brush tailed possum), which cause considerable economic and environmental damage in New Zealand.

Two shallow monitor bores, sited 5 and 13 m from the disposal pit, were sampled weekly for five weeks and thereafter monthly for 13 months. Analyses detected 1080 in 5 of the 28 groundwater/leachate samples. The 1080 concentrations in those samples, except for one result, were low. These were either below or close to the Ministry of Health provisional maximum acceptable value standards (PMAV) for drinking water, currently 0.005μg ml^{-1}.

The concentrations of 1080 in groundwater in the more distant bore (13 m) were markedly lower than those in the nearer bore (5 m). 1080 was first detected in the near bore after 5 weeks and the more distant bore after 16 weeks. The level and frequency of incidence of 1080 in both holes decreased over the sampling period until none was detected after 10 months.

In situ sampling of the residual waste material indicated the 1080 concentration in the disposal pit decreased to less than 10% of its original level in 12 months. The active anaerobic bacterial processes operating in the organic refuse pile appear to provide an ideal environment for the rapid natural breakdown of 1080. The findings will assist with the setting of conditions for resource consents concerning the disposal of materials containing 1080 in landfill sites.

Keywords: Sodium monofluoroacetate; leaching; groundwater; disposal.

Introduction

This paper describes a monitoring study designed to gain a greater understanding of the fate of 1080 in landfill sites and its effects on groundwater. The results provide a basis to make more informed resource management decisions on the disposal of 1080 materials.

The use of compound 1080 (sodium monofluroacetate) as a vertebrate toxin in New Zealand is strictly regulated (i.e., Pesticides Act 1979; Pesticides (Vertebrate Pest Control) Regulations, 1983; Toxic Substances Act, 1979; Resource Management Act, 1991). More knowledge, however, is needed about the impact of 1080 the environment and the possible risks it poses to public safety. There is only limited knowledge about the behaviour of 1080 in ground water (Parfitt *et al.,* 1994). As resource consent conditions on landfill sites are becoming more stringent it is increasingly difficult to dispose of waste material containing 1080.

In August 1996 Southland Regional Council biosecurity staff disposed of approximately 12 000 kg of 1080 cereal pellet and paste bait materials. This bait had had been intended for Animal Health Board possum control operations in Southland in 1996 but was condemned as unfit for use because it had deteriorated in storage. It was buried in a specially constructed pit at the Southland District Council's landfill at Winton in central Southland. This was an accepted method (label instructions) for disposal of 1080 waste that had been used previously at this and other sites in the region. However, neither the Southland District Council or Regional Council biosecurity staff involved were familiar with resource consent conditions imposed in 1995. These specified that no 'hazardous substances' could be disposed of in this land fill site. By the definition waste 1080 bait qualifies as a hazardous substance.

This 1080 bait disposal issue became a matter of considerable public interest. The Council consulted a range of technical experts and reached the following conclusions:

- The 1080 waste in the disposal site did not present an immediate public health or environmental hazard because toxic materials were apparently contained and would break down naturally under bacterial action.
- It was not feasible to remove the toxic material and dispose of it elsewhere at a legally approved site.
- The Council would implement a programme to monitor the disposal site in order to ensure that the contamination was contained and to establish that natural breakdown was occurring.

Methods

Design

A monitoring programme was designed to meet the following objectives:

1. To determine if 1080 contamination was present in ground water adjacent to the disposal site and if so, what changes were occurring in space and time.
2. To confirm that 1080 was being broken down *in situ* by natural bacterial processes in the disposal site.

The Winton landfill site

The Winton landfill is located in central Southland (NZMG E45 495417) on a flat area of flood plain 500 m west of Winton township. The tip occupies an area of approximately 2 ha and comprises a series of abandoned gravel pits up to 5 m in depth. The site has been used by the Southland District Council as a managed solid waste disposal site for local domestic refuse and operates under a discharge permit granted by the Southland Regional Council in May 1995.

The substrate comprises coarse gravels overlain by a veneer of alluvial soils. The Winton Stream and a smaller tributary lie approximately 200 m east and west of the tip site, respectively, and both flow southward. The natural water table, as evidenced by streams and ponds in the vicinity, lies approximately 1.0-1.5 m below the ground surface. Ground water flows in the tip area were assumed to be from NNE to SSW consistent with the regional gradient and surface water flows. There is an average annual rainfall of 880 mm. The site is surrounded on three sides by pasture and to the north by a sawmill.

Description of the waste 1080 disposal process

On 13 August 1996 a site was selected 20 m behind the active disposal face, in an area that would not be disturbed in future. An hydraulic back hoe excavator was used to dig a hole 4 m x 1.5 m to approximately 3 m in depth. This was dug entirely in waste fill material comprising soil, organic matter and the remains of other household refuse (i.e., plastics, wood, metal, etc). This material had an elevated temperature indicating a high level of biological activity. No water was encountered in the base of the pit during excavation indicating it had not penetrated the natural water table. The waste toxic bait material was placed in the hole and covered by a one metre thick layer of waste fill.

The buried materials included:

- 11 000 kg of cereal pellet bait with a nominal toxic loading of 0.15% 1080 by mass (standard WS7 type 6 g baits contained in 25 kg paper sacks).
- 40 x 20 l plastic pails (opened) of apple paste bait with 1080 at a nominal toxic loading of 0.08%.

Installation of bore holes

On 13 September 1996 two shallow monitor bore holes (Bore 1 and Bore 2) were installed on the accessible south side of the disposal pit along the assumed direction of ground water flow. Lengths of 150 mm diameter plastic water pipe, with slotted bases and permeable gauze end covers, were installed. The base of the hole, around the lower 30-50 cm of the pipe, was then packed with permeable pea gravel. The hole was back filled to surface using excavated refuse and the top of the pipe was capped. The nature of material in the hole and other relevant information was recorded before back filling. (Fig. 1).

- Bore 1 was 5 m south of the disposal pit. It was sunk to a depth of 2.7 m below surface that was approximately the same level as the base of the disposal pit. It did not breach the gravel base of the landfill but anoxic water was noted in the basal 30 cm of the installation hole.
- Bore 2 was 13 m south of the disposal pit (and 8 m south of Bore 1) on the gravel pad about 2.0 m below the level of the adjacent waste fill area where the disposal pit is sited. Bore 2 was 2.0 m deep and intersected a 20 cm layer of gravel laid over 50-80 cm of older refuse material. Below that medium to fine muddy gravels comprising the base of the old gravel pit were encountered. A relatively strong ground water/leachate flow was noted (estimated at a <5 l sec^{-1}) into the base of the hole suggesting the water table was at approximately 1.5 m below surface.

The site was surveyed to obtain the location of the disposal pit, the bore holes and to establish the reduced levels of the water table.

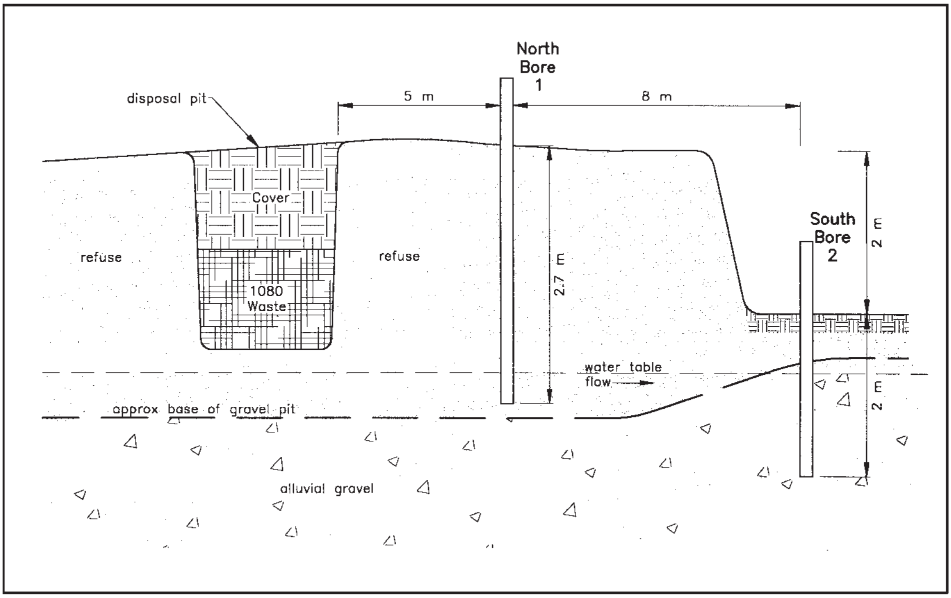

Figure 1: *Diagrammatic cross section through the 1080 disposal site showing the location of the investigation bore holes and water table (not to scale).*

Groundwater sampling

Water samples were taken at weekly intervals for the first 5 weeks and thereafter monthly for a period of 13 months. Sampling involved using a small battery driven submersible pump to take samples from the bottom of each bore. The pump was run for 10 min and if necessary the bore was allowed to recharge before a sample was taken. Water temperature was recorded. Approximately 500 ml of sample was sealed in a clean bottle and transported in an insulated container chilled with icepacks to Invercargill. Here samples were frozen to prevent further natural breakdown of 1080 in the sample. Samples were consigned to Landcare Research NZ Ltd's IANZ registered laboratory at Lincoln normally arriving within 24 h. The analysis for groundwater samples was carried out by gas liquid chromatography (TLM 005), with a detection limit of 0.0001 $\mu g\ ml^{-1}$.Additional samples were tested for water quality (pH, conductivity, biochemical oxygen demand, ammoniacal nitrogen and fluoride). This was carried by the Regional Council's own IANZ registered laboratory (Bowman, 1998).

Solid waste sampling

Two sets of grab samples were taken from the toxic bait materials in the disposal pit to determine the degree and rate of decomposition, in October 1996 and in October 1997. The cover layer over the disposal site was removed and one sample was taken at the first appearance of bait material and another approximately 30 cm down into the waste mass. The material sampled comprised a sludge-like mixture and it was not possible to determine what proportion of cereal pellet or paste bait material was present. The 1080 content was measured by gas liquid chromatography (TLM023) with a detection limit of 0.3 $\mu g\ g^{-1}$.

Results and Discussion

Groundwater

Sodium monofluororacetate (1080) was detected in 5 of the 28 ground water samples analysed. In Bore 1, 1080 was present above the detection level (0.0001 $\mu g\ ml^{-1}$) on three occasions out of the 14 sampling dates. The highest at 0.024 $\mu g\ ml^{-1}$ occurred on 18 October 1996, 5 weeks after burial. Two other readings of 0.007 $\mu g\ ml^{-1}$ and 0.0004 $\mu g\ ml^{-1}$ occurred on 20 January 1997 and 17 April 1997 respectively. In Bore 2, two measurements were above detection level: 0.0006 and 0.0001 $\mu g\ ml^{-1}$ on 24 January 1997 and 24 February 1997, respectively.

These 1080 concentrations measured in the groundwater were low. Two of the 28 measurements exceeded the New Zealand Ministry of Health's Provisional Maximum Acceptable Value for 1080 levels for drinking water of 0.005 $\mu g\ ml^{-1}$. It should be noted the limits include a 1000x safety factor (Eason, Wickstrom and Turk, 1998).

No 1080 was detected in Bore 1 until 5 weeks had elapsed. This suggests that the organic refuse pile may have a low permeability and tended to contain rather than convey leachate. Thereafter 1080 was found sporadically at very low levels. These concentrations progressively decreased until after August 1997 when no further 1080 was detected. The nature of the organic debris and the heat being generated (30-45°C) suggests that biological activity rapidly breaks down of the 1080 *in situ* as well as in the groundwater leacheate.

In Bore 2 no 1080 was detected in water sampled from the underlying gravel base until 5 months after the burial of the bait. These concentrations were extremely low (close to the detection limit). This suggests that the relatively impermeable overlying organic refuse is restricting the ingress of leachate into the more permeable underlying gravel layers. Higher ground water flow rates in the underlying gravels are also likely to create a greater dilution effect.

The groundwater monitoring showed that the 1080 in the waste materials was effectively contained within the immediate vicinity of the disposal pit. There was also a clear overall reduction in 1080 level over the period of monitoring and no measurable 1080 was detected during the last 6 months of sampling. The decline in 1080 levels in ground water away from the disposal site suggested natural breakdown was taking place. The risk of 1080 passing through ground water flows to humans or causing negative environmental effects was negligible.

The water quality data were typical of landfill leachate with little variation in the parameters. Bore 1 had elevated biological activity, sustaining high temperatures (30-45°C regardless of season) and relatively invariant chemical parameters indicating a highly buffered leachate rich in total dissolved solids. Bore 2 with lower levels of biological activity was closer to background water quality. Fluoride results, however, were consistent with Bore 1.

Solid sampling

The results of the sampling of the residual waste bait material showed that 10 weeks after burial the degradation of the 1080 had started on the upper surface of the waste bait mass but had not affected the core. The top sample was reduced to one third of its original concentration while the deeper sample was still at the original concentration. After a further 12 months the degradation process had advanced considerably. At this time the material on the upper surface had reduced to 20% and the lower sample to 7% of its former concentration. There were insufficient data to determine the actual decay rate. However, 1080 was breaking down *in situ*.

Implications for future disposal of 1080 materials in landfill sites

The monitoring study indicated that the 1080 waste materials buried in a purpose-dug pit at the Winton landfill, following approved procedures, did not appear to pose any significant risk to public safety or the environment, providing the site is not disturbed and natural breakdown processes are able to continue. The active anaerobic bacterial processes operating in the organic refuse pile appear to provide an ideal environment for the rapid natural breakdown of 1080. The monitoring study ceased in October 1997 and no further work is planned.
The monitoring study was not intended to provide definitive evidence to support the use of managed solid waste landfill sites as the preferred means for the disposal of 1080 waste material. However, the results presented do not contradict this proposition, and will be useful when setting conditions for resource consents for landfill sites.

Acknowledgements

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