CRITIQUE of the 'Investigation into Concerns Regarding Seepage Water in a Rosebery locality - Final Report from the Project Team' (DHHS, EPA 2009)."

This critique has been compiled by the Toxic Heavy Metals Taskforce Tasmania and an Independent Environmental Scientist.

Introduction

Several Rosebery residents advised the Department Health and Housing Services (DHHS) and Environmental Protection Authority (EPA), of concerns regarding environmental contaminant exposure to heavy metals during October 2008. DHHS and EPA subsequently established a 'Project Team' to develop / implement an onsite investigation of potential contaminant exposure pathways and assess potential health effects.

The project team's findings and recommendations were detailed in a **Final Report** titled:

'*Investigation into Concerns Regarding Seepage Water in a Rosebery locality – Final Report from the Project Team'* (DHHS, EPA 2009).

This critique provides a review of the report and aims to highlight potential:

- Gaps in the information presented;
- Issues associated with the project methodologies;
- Alternative interpretations of the data; and finally
- Present recommendations for further work and more detailed assessments.

The following aspects are acknowledged:

- The serious nature of the complaints received by DHHS / EPA; and
- The limited response time available for the project team to establish a cohesive framework for assessment of potential health effects. (This was acknowledged by Professor Brian Priestly)

These factors restricted the scope of the investigation and the level of detail provided. Similarly, mistrust between residents and regulatory authorities confounded the report conclusions.

Establishing the extent, distribution and potential health effects of exposure to metals / metalloids, in the broader community, requires detailed assessment of various environmental media over many years. A population level epidemiological investigation is also required.

Some fundamental issues with the report are related to:

- The types of sampling methodologies used;
- Data interpretation / presentation; and
- Investigation conclusions.

Critique Structure

The first section details key recommendations for future work. It is followed by a brief assessment of the report, which is divided into sections dealing with various environmental media including; soil, water, dust, gas etc.

Key Recommendations for Future Investigations

- Further investigation into potential exposure related health effects are warranted;
- The scope of any future project should be expanded to include the nature, magnitude and extent of potential contamination / exposure effects on the broader community and environment. With a particular emphasis on sensitive persons and environmental receptors;
- Reinvestigation of soils is warranted to establish / or rule out the presence of thallium;
- Detailed assessments that establish the 'cumulative risk' of exposure to soil, water (drinking, ground / seepage and surface waters), dust, home grown food (vegetables, fish, poultry and eggs etc) and occupational exposures are required;
- This contrasts with the risk assessment process used in the report, which focused on each exposure pathway separately and failed to acknowledge the potential for cumulative effects;
- It is important that occupational / lifestyle exposures to metals (both current and past) are integrated into the risk assessment process;
- Future investigations should be conducted by an 'Independent' University or other research institution and all results made publicly available;
- Results should be released progressively as interpretation is completed and any appropriate precautionary measures publicly released
- Accepted scientific peer review processes should apply;

Assessment of the Final Report

<u>Soils – potential sources</u>

Page 5 of the Final Report lists potential soil contaminant sources. It failed to include:

- Potential for historic mining processes to have occurred at the site;
- Seepage water incursion;
- The presence of underground tanks or waste associated with historic activities (mining or otherwise), at the site. Storage of fuel could explain the exceedingly high soil lead levels.

<u>Soils – Investigative techniques</u>

No attempt to complete isotope, or correlation analysis was made by the project team.

Lead isotope analysis can be used to establish the source of lead in surface soils. It can potentially determine if soil lead is associated with mineralization, disposal of car batteries, fuel contamination, paint, or otherwise.

Similarly, correlation analysis (comparing concentrations of element 1, with concentrations of element 2, 3, 4 etc) could have been used to determine if the soil contaminants were derived from the same, or combination of particular sources.

It follows, that if lead isotope analysis had shown soil lead was derived from source A, and correlation analysis showed that concentrations of lead, cadmium and zinc were highly correlated, then the major contributor of these contaminants in soil would be source A.

Despite the presence of exceedingly high concentrations of lead (up to15 times the Health Investigation Level for residential premises), Arsenic (up to 6 times the HIL), and cadmium (up to 7 times the HIL) the following tasks were not completed:

- Excavation of pits, trenches etc, to ascertain if tanks, waste or other contaminating material exists at depth;
- Use of ground penetrating radar for the same purpose.

Additionally:

- Soil sampling was restricted to the top 30cm of soil at the site, thus providing no indication of contaminant levels at depth. It is acknowledged that metal / metalloid concentrations appeared to decrease in the first 30cm, but additional work is warranted;
- No X-ray Diffraction (XRD) analysis was completed, to establish the mineral form of the contaminants. Knowing which minerals the metals are associated with can provide clues as to the source, and allows predictions regarding the mobility and potential bioavailability of the element to be made;
- Most open cut mines regularly collect atmospheric dust to determine total dust deposition rates. It should have been possible to test these samples for total metals, thus assessing if mine generated dust is loading residential soils with metals. This was not completed; Despite the very high contaminant levels at the four homes, there was no recommendation to expand the study into adjacent premises, or the broader Rosebery municipality. This was clearly warranted.

Soils – Sample collection and quality assurance

It is recognised that the exact location of houses included in the investigation may have been omitted for privacy reasons. However, the houses could have been labelled residence A, B, C etc and referred to accordingly. The absence of appropriate labelling makes it difficult to relate the text to the mud map provided. Similarly, the location of drains, contours and nearby mining infrastructure referred to in the text, were omitted.

It is unclear if composite soil sampling (samples collected from across the site, bulked and then sub-sampled) was completed. Composite sampling is typically completed as a 'first run' to determine if soil metal concentrations are broadly compliant with specified guidelines.

If required, a more detailed assessment that targets specific areas of concern is then completed. None of this information is provided in the body of the report.

The report acknowledges that metal sulphide rocks were identified at one property, yet rocks were removed from the samples prior to analysis. The report does not state that the discarded material was assessed to ensure it was not sulphide bearing material, which could have contributed to metal elevations within the soil.

The report indicates that analytical procedures associated with soil analysis were shown to be 'accurate' because similar results were received for the duplicate sample. In reality the close match in results only shows that the analytical procedure was 'precise', ie. it produced repeatable results.

Precision is a measure of repeatability, while accuracy relates to how closely a result is to an 'actual known value'. Accuracy can only be assessed using a standardised sample for which the concentration of elements is previously known. There was no discussion of any such sample in the report. There is no justification given for inclusion of particular metals in the soil sampling suite. The report does not state that ore / waste rock characterisation was considered when developing the suite of metals to be included in the analysis.

Thallium is a notable omission from the sample suite. It is a rare, but highly toxic element that very occasionally occurs in association with types of ore deposits mined at Rosebery.

Toxic Heavy Metals Taskforce Tasmania confirmed that the presence of thallium has been noted at the Rosebery mine. Given the potential toxicity of thallium, reinvestigation of soils is warranted to establish / or rule out the presence of this element.

Soils – Data presentation / interpretation

Locations where Health Investigation Levels (HIL's) were exceeded were shown in Figure 4, but it is not possible to determine if the exceedence occurred in surface, or sub-soils.

Typically, a table (or series of tables) shows:

- All the analysis results;
- Clearly states the HIL for each element; and then
- Highlights any HIL exceedence.

No such table exists in the body of the Final Report and the copies of the supplied appendices could not be easily read. As such, it was not possible to get a holistic picture of the analysis results and the reader relies on the author's interpretation. Legible copies of the appendices should be reviewed to determine if this information is available.

High metal concentrations in sample S08 were attributed to the presence of partially buried galvanised sheet. This would explain the presence of elevated iron, and zinc, but does not account for elevated levels of more toxic metals such as; lead, cadmium, copper, nickel etc. It seems possible that other metal containing materials may also be buried at this location and the area should be locally excavated.

13 of the 20 surface soil samples exceeded at least one HIL for residential sites. The report fails to state that:

The maximum lead soil concentration was 15 times the Health Investigation Level for residential premises (HIL);

The maximum arsenic soil concentration was 6 times the HIL; and

The maximum cadmium concentration was 7 times the recommended HIL.

The report ignored the worst case exposure scenarios in favour of using means. This is misleading because:

Assessment of potential exposure should be based on a worst case

scenario to ensure public safety; and

The metal concentrations were averaged across the 4 premises, yet an

occupant is only exposed to the soil in their own yard;

As such, the worst case scenario, or alternately the maximum elemental concentration for each particular yard, should be used in exposure risk calculations.

For instance:

Using the mean concentration for lead, the project team calculated that lead exposure to soil, for a 50Kg adult, accounted for 5.39% of the proposed tolerable weekly intake (0.025 mg/Kg); In contrast, using the highest lead concentration would have accounted for 64.12% of the proposed weekly tolerable intake (or ten times as much).

Now let's consider the worst case scenario for a two year old child exposed to the soil with the highest identified lead concentrations. The assumptions are that:

- A 2 year old child ingests a greater amount of soil than adults, this is due to continual hand – mouth contact (100mg / day);
- Weighs less than an adult (approx 20 Kg); and
- Is exposed to the highly contaminated soil on a daily basis.

The specified soil ingestion rate is taken from *'enHealth Guidelines for Assessing Human Health Risks from Environmental Hazards 2002'*. This document is used in establishing Australian soil exposure standards.

The calculations show that exposure to soil in the 2 year old infant would account for up to 642% of the proposed tolerable weekly intake of lead. Or to put it another way, the toddler's exposure to soil could result in consumption of up to

six times the proposed tolerable weekly intake of lead. This calculation does not take into consideration any additional lead exposures from dust, paint, toys, food, water and air. It was not presented in the final report.

Clearly, further data analysis by an appropriately qualified person is warranted.

Water – Sampling locations

As noted earlier, Properties A – C and sample numbers are not marked on the site plan. As such, it is difficult to establish which results relate to a particular location.

Water – Sample methodology

The Final Report failed to state if the samples were provided to the laboratory in the required time frame.

Some water samples were collected using a syringe then filtered through a fine filter, prior to submission to the laboratory. Metals typically attach to fine sediment fractions, so this may have removed metals from the samples prior to analysis. The separated fraction should have been analysed separately.

The report states that elevated metal concentrations in a seep water sample (collected on October 8th 2008) were likely attributable to the presence of significant amounts of particulate matter in the 'muddy puddle'.

Another water sample collected on the 8th of October was analysed for total chromium concentrations and found to exceed the relevant guideline (see top of page 27). When the sample was analysed for dissolved chromium, it was not detected. The report concludes this was because the chromium existed in an 'insoluble' trivalent form (associated with sediment).

The report disregards the presence of hexavalent chromium (a toxic substance), concluding that it was highly soluble and stating that its absence in the filtered sample meant they were dealing with the less dangerous / insoluble trivalent form.

That assumption is incorrect. The US Centers for Disease Control fact sheet on hexavalent chromium clearly states that:

'Hexavalent chromium compounds vary in solubility from those that are readily soluble to those that are practically insoluble in water'.

The CDC goes on to state that:

'All hexavalent chromium compounds, regardless of their degree of solubility in water should be considered occupational carcinogens'.

Water – Quality assurance

The report confuses the terms 'accuracy' and 'precision' (see notes in 'Soils – Sample collection and quality assurance', for a discussion of terminology).

Water – Discussion of results

It is standard practice for the laboratory results to be presented in tabular form within the body of the report. A range of potentially applicable guidelines are usually shown, and any exceedences highlighted. This information is not presented in the project team's report.

The report simply compares the water quality results with the Guidelines for Recreational Water Quality (NHMRC 2008). The criteria specified in these guidelines are significantly less stringent than those set for human consumption, or protection of aquatic ecosystems and vary considerably from stock water guidelines.

Despite the non-stringent nature of the adopted guidelines, 3 of the 9 samples collected exceeded acceptable limits for at least one of the elements; lead, arsenic, or manganese. The report neglects to say by how much. The exceedence of the chromium guideline, in the unfiltered water sample, is only briefly mentioned yet significant.

The following table presents a summary of relevant water quality guidelines, which should have been further discussed in the report.

Table 1 – Summary of some relevant water quality guidelines

Water quality guideline	Relevance
Human consumption guidelines	Small children may drink seep water directly. The boggy nature of the yards means there is also potential for hand – mouth exposure to water.
Stock watering guidelines	Pets inhabit back yards and will drink directly from seep / storm water. Many pets are known to have died in the area. At least one was believed to have symptoms consistent with poisoning. Adoption of stock watering guidelines would provide a useful basis for further assessment of potential impacts on animals.
Protection of aquatic ecosystems, or other relevant surface water quality guideline	Storm and seep water eventually enter down stream rivers and lakes. These waterways will have prescribed environmental values that must be protected and not compromised by contaminated inflows. This is a regulatory requirement.

Issues with laboratory accreditation meant that seep water analysis for the mine flocculent - sodium ethyl xanthate (SEX) was not completed.

The first round of cyanide samples were not submitted to the laboratory in the required time frame (Cyanide has a very short half life). Repeat samples were not collected until 3 weeks later and cyanide was not detected.

The report recognises the widespread distribution of waste rock as road base and land fill throughout the Township of Rosebery. It highlights the waste rocks potential to adversely affect water quality (page 31). However, the report fails to recommend further investigations into ground / surface waters throughout the Township. Clearly, this is required.

Gas Investigation - Screen testing

The instrument used to conduct testing had insufficient resolution to establish if Hydrogen Sulphide (H_2S) was present in concentrations capable of causing general discomfort, irritation and non-sensory effects in residents.

The report concluded that seep bubbles were being formed by a gas other than H_2S, but did not discuss any of the results obtained for O_2, SO_2, NO_2, or CO during the sampling events. It presented no appropriate guidelines for these gases.

Gas – detection of H_2S – using radiello cartridges

H_2S monitoring using this method appeared to produce satisfactory results.

Unfortunately, it was not known if seeps were bubbling during the sampling event. If they were not, the sampling may not have been useful and should be repeated at a time when the seeps are bubbling. Occupants should be asked to keep notes of when bubbling occurs, for comparison with results.

Gas Screening – Arsine Gas

Arsine gas monitoring was restricted to a single 8 hour underfloor sampling event at two premises. Arsine gas concentrations were low, but it was not stated if the seeps were bubbling at the time of sampling. If they were not, the sampling may not have been useful and should be repeated at a time when the seeps are known to be expelling gas. Occupants should be asked to keep notes of when bubbling occurs, for comparison with results.

Given the intermittent nature of bubbling at the site a single 8 hour sampling period seems insufficient to draw any satisfactory conclusions regarding potential health effects of exposure. No indoor arsine gas monitoring was conducted.

Dust sampling

Residents did not allow the contracted consultant to obtain dust samples from their homes. Rather, residents collected their own vacuum cleaner samples using domestic vacuum cleaners. This likely produced spurious results.

In the absence of guideline levels for indoor dust, HILs for residential soils were adopted for comparison purposes. However, calculations similar to those completed for intake of metals from soils, should also be completed and compared to the proposed tolerable weekly intakes.

Much is known about the potential effects of contaminated dust exposure in infants through hand-to-mouth activity within the home environment and robust methods for calculating potential ‘worst case exposure scenarios’ are available in the scientific literature. These should be adopted in future investigations.

Biological monitoring

The lack of clear cooperation and communication between residents and regulatory officials confounded development of clear conclusions. Very little data

is presented in this section of the report and no information from medical examinations is provided.

The report provides insufficient evidence to establish clear causation of ill-health, or to dismiss contamination exposure as a significant contributor to the poor health outcomes of residents.

Establishing causation of any potential elevated blood / urine levels in future investigations would require a population based study of the Rosebery community.

Assessment of cumulative exposure risk

No cumulative exposure analysis was included in the report. Rather risks associated with exposure to soil, water, dust, and gas were dealt with in isolation. No assessment of potential risks associated with local food consumption was included in the report.

An appropriate cumulative exposure model would sum potential metal intake from a range of sources including; soil, air, dust, water (drinking and seep water), food and other occupational environments.

The cumulative result could then be compared with a tolerable weekly intake, or other appropriate maximum exposure standard to determine if health risks exist.

This critique does not identify all the issues associated with the report. Nor does it present all the solutions. The critique will require revision, prior to commencement of any subsequent investigations.