# final report

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# Assessment of Contaminants in Waste Solids from Meat Processing Wastewater Streams

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# Executive Summary

In November 2001, the Queensland Environmental Protection Agency (EPA) released a discussion paper for the *Beneficial Use of Specified Organic Wastes* to review the current status of the management of all types of organic waste in Queensland. In response to these moves by the Queensland Government, MLA commissioned GHD to undertake project PRENV.023a – *Assessment of Contaminants in Waste Solids from Meat Processing Wastewater Streams* – to provide scientific data on abattoir and rendering plant solid wastes, enabling the industry to take an informed position on the issue.

During August 2002, GHD visited four meat processing facilities in south-east Queensland for the collection, analysis and grading of several solid waste streams. All procedures were undertaken in accordance with the requirements of the N.S.W. EPA *Environmental Guidelines: Use and Disposal of Biosolids Products*. From these four processing facilities, a total of 15 solid waste streams were sampled and analysed for the heavy metal and organic contaminants listed in Table 3-1 of the N.S.W. *Environmental Guidelines*.

In summary, all 15 solid waste streams were shown to be compliant with all the Grade B contaminant thresholds. Thirteen of the 15 solid waste streams complied with all the Grade A contaminant thresholds. Coupled with a Stabilisation Grade A, these solid wastes would be classified “Unrestricted Use”, suitable for home lawns and gardens, as per the criteria outlined in Table 3-6 of the N.S.W. *Environmental Guidelines*.

Only two solid waste samples did not meet the Grade A thresholds for the following contaminants:

- Zinc concentrations were above the Grade A threshold limit in the BFP cake of Processing Facilities Nos. 1 and 2;
- The copper concentration in the BFP cake at Processing Facility No.1 was above the Grade A threshold limit; and
- The chlordane concentration in the BFP cake at Processing Facility No.1 was above the Grade A threshold limit.

MLA should consider further investigation of these results, in consultation with the relevant processing facilities, to identify any site-specific causes for the elevated readings.

This report on project PRENV.023a provides MLA with scientific data on the low concentrations of heavy metals and organic contaminants present in organic wastes from abattoirs and rendering plants. This will assist the industry in further discussions with the EPA over organic solid waste management issues.

# 1. Introduction

## 1.1 Scope

In November 2001, the Queensland Environmental Protection Agency (EPA) released a discussion paper for the *Beneficial Use of Specified Organic Wastes*.[1]. The purpose of this discussion paper was to review the current status of the management of organic wastes in Queensland and develop "an overall policy for beneficial and sustainable reuse of specified organic wastes". Such wastes are defined as "sludges from sewage treatment plants, **abattoirs, rendering plants**, diary processing plants, and canneries" and "animal manures from feedlots, piggeries and poultry farms".

In light of this objective to develop an overall policy for the management of all solid wastes in Queensland, the discussion paper notes the lack of data on biosolids production and composition, particularly from the abattoir and rendering industries. GHD has subsequently been engaged by Meat & Livestock Australia (MLA) to undertake project PRENV.023a – *Assessment of Contaminants in Waste Solids from Meat Processing Wastewater Streams*. The aim of this project is to provide MLA with scientific data on abattoir and rendering plant solid wastes, enabling the industry to take an informed position on the issue.

Over the period 29 July – 16 August 2002, GHD collected solid waste samples from four meat processing facilities in south-east Queensland. Samples were subsequently analysed for the contaminants listed in Table 3-1 of the N.S.W. EPA's *Environmental Guidelines: Use and Disposal of Biosolids Products*[2]:

- Arsenic;
- Cadmium;
- Chromium (total);
- Copper;
- Lead;
- Mercury;
- Nickel;
- Selenium;
- Zinc;
- DDT/DDD/DDE;
- Aldrin;
- Dieldrin;
- Chlordane;
- Heptachlor;
- HCB;
- Lindane;
- BHC; and
- PCBs.

This report summarises the analytical results from the four processing facilities, together with a comparison of the results against the contaminant thresholds of the N.S.W. EPA *Environmental Guidelines*, as well as other state and national biosolids guidelines.

[1] Queensland EPA, (November 2001). *Discussion Paper for Beneficial Use of Specified Organic Wastes for EPA*.

[2] N.S.W. EPA (1997). *Environmental Guidelines: Use and Disposal of Biosolids Products*.

## 1.2 Background

Currently, the management of solid wastes from abattoirs and rendering plants in Queensland is regulated under the *Environmental Protection Regulation 1998* (EP Reg) and the *Environmental Protection Act 1994* (EP Act)[1]. Schedule 1 of the EP Reg identifies both abattoirs and rendering plants as Environmentally Relevant Activities (ERAs) (ERA 32 and ERA 50 respectively). However, at present there is no clear policy or guidelines for the management of organic solid wastes in Queensland.

As an interim measure, the EPA has produced an *Operational Policy: Beneficial use of biosolids* (January 2002) to provide a framework for consistent application and interpretation of the legislation. This *Operational Policy* draws on the technical framework of the N.S.W. EPA *Environmental Guidelines*, and is effective until January 2003.

Consequently, the purpose of the Queensland EPA's current discussion paper is to seek comments for the release of formal guidelines early next year. Presently, one of the favoured options for the EPA is the adoption of a technical framework based on the N.S.W. EPA's *Environmental Guidelines* for **all** organic wastes.

The red meat processing industry generates significant volumes of waste solids, which mainly comprise:

- Paunch contents (from the stomachs of ruminant animals);
- Manure from lairage;
- Screenings, floated fatty material, settled solids, anaerobic pond scum and biosolids from wastewater treatment systems; and
- Waste cardboard and other packaging materials.

These solids (with the exception of cardboard and packaging materials) are derived from processing of food animals, and therefore typically contain negligible concentrations of heavy metals and pesticides. Adopting the N.S.W. EPA's *Environmental Guidelines* for all waste solids in Queensland would impose requirements for repeated sampling and testing of waste solids batches for contaminants that are unlikely to be present, especially heavy metals and pesticides[3].

Therefore, this project seeks to gather scientific data on the heavy metal and pesticide concentrations in waste solids from abattoir and rendering plants. This will allow the meat processing industry to adopt an informed position on the issue of organic solid waste management, in their discussions with the Queensland EPA.

[3] Meat & Livestock Australia (June 2002). *Terms of Reference: PRENV.023a – Assessment of Contaminants in Waste Solids from Meat Processing Wastewater Streams.*

# 2. Project Methodology

## 2.1 General

During the period 29 July – 16 August 2002, GHD visited four meat processing sites in south-east Queensland to collect solid waste samples for this study. The personnel involved were:

- Chris Hertle
  Principal Process Engineer, Water and Wastewater Treatment
- Jeff Foley
  Process Engineer, Water and Wastewater Treatment
- Michael Lane
  Principal, Ecolutions (Aust) Pty Ltd
  (attended first facility only)

Solid waste samples were collected from the sources shown in Table 1 below.

**Table 1 Solid Waste Sampling Locations**

| Material Sampled | Processing Facility No.1 | Processing Facility No.2 | Processing Facility No.3 | Processing Facility No.4 |
|---|---|---|---|---|
| Paunch contents | ✓ | ✓ | ✓ - note 1 | ✓ |
| Lairage manure | | ✓ | | ✓ - note 4 |
| WWTP screenings | ✓ | | ✓ - note 2 | ✓ |
| WWTP BFP cake | ✓ | ✓ | | |
| DAF float | | ✓ | | |
| Save-all sludge | | ✓ | | |
| Anaerobic pond scum | | | ✓ | |
| Composted biosolids | | | ✓ - note 3 | |

Notes:

1. Sample taken from save-all on “green stream” (containing paunch contents). Also incorporates DAF float and “red stream” screenings (main abattoir wastewater stream).
2. Sample taken from rotary screen on “red stream” from abattoir.
3. All solid waste composted in windrows and stored on site (up to 5 years). Sample taken from piles of well-composted material.
4. Sample taken from rotary screen on wash water from cattle pens.

## 2.2 Environmental Guidelines Sampling Procedure

Schedule 1 of the N.S.W. EPA *Environmental Guidelines: Use and Disposal of Biosolids Products* specifies the sampling and analysis procedures required for sewage treatment plant biosolids. Where possible, this sampling and analysis procedure was adopted for the collection of solid waste samples at the four meat processing facilities.

### 2.2.1 Sampling Equipment

In accordance with section 1.3, Schedule 1 of the *Environmental Guidelines*, the following equipment was used to collect the solid waste samples:

- Stainless steel trowel;
- Stainless steel mixing bowl;
- Clean 250 mL borosilicate glass sample containers, with screw-on plastic lid. Sample containers stored in bubble wrap to prevent breakages; and
- High impact plastic cooler (esky) with ice bricks (for transport to the laboratory).

### 2.2.2 Sampling Method

The following sampling methodology was used for each sample collected:

1. Collect at least 5 grab samples from solid waste stream using stainless steel trowel.
   - Sampling locations were in accordance with section 1.2.2 of Schedule 1.
2. Mix grab samples in stainless steel mixing bowl using stainless steel trowel.
3. Fill 250 mL glass sample container with composite solid waste sample.
4. Secure plastic lid and mark sample container with the following information:
   - Name of processing facility;
   - Sampling location;
   - Sample number; and
   - Date and time of sampling.
5. Wrap glass sample container in bubble wrap and store in cooler.

Each solid waste stream was sampled in triplicate. Sampling equipment was washed thoroughly in hot water between sampling.

Upon completion of site inspections, the solid waste samples were couriered to the Australian Government Analytical Laboratories (AGAL) at Cannon Hill, QLD. AGAL is NATA-registered for all analyses undertaken in this study.

All sample containers were accompanied by a GHD Chain of Custody Record. These records have been retained in the GHD project file for QA purposes. AGAL also retained a replicate of the Chain of Custody Record for their files. AGAL retain samples for one month from the date of the final report, and records are kept on file for three years.

### 2.2.3 Analyses

Outlined in Table 2 are the analyses undertaken by AGAL on all samples.

**Table 2 Solid Waste Analyses**

| Parameter | Limit of Reporting | AGAL Method ID No. | Method Description |
|---|---|---|---|
| Total Solids (TS) | 0.1% w/w | NT2_49 | APHA 2540 B, gravimetric |
| Volatile Solids (VS) | 0.1% w/w | NW_SL1 | APHA 2540 E, dried at high temp., gravimetric |
| pH | 0.1 pH unit | NW_SL7 | NSW Dept Ag., 1:5 (soil:water) extraction, pH meter |
| Arsenic (Ar) | 0.5 mg/kg | NT2_49 | USEPA 200.8, 200.87, 3050 (modification) |
| Cadmium (Cd) | 0.2 mg/kg | NT2_49 | USEPA 200.8, 200.87, 3050 (modification) |
| Chromium (total) (Cr) | 0.5 mg/kg | NT2_49 | USEPA 200.8, 200.87, 3050 (modification) |
| Copper (Cu) | 0.5 mg/kg | NT2_49 | USEPA 200.8, 200.87, 3050 (modification), $HCl/HNO_3$ digestion |
| Lead (Pb) | 0.2 mg/kg | NT2_49 | USEPA 200.8, 200.87, 3050 (modification) |
| Mercury (Hg) | 0.01 mg/kg | NT2_49 | USEPA 200.8, 200.87, 3050 (modification), ICPMS/AES |
| Nickel (Ni) | 0.5 mg/kg | NT2_49 | USEPA 200.8, 200.87, 3050 (modification) |
| Selenium (Se) | 0.5 mg/kg | NT2_49 | USEPA 200.8, 200.87, 3050 (modification) |
| Zinc (Zn) | 0.5 mg/kg | NT2_49 | USEPA 200.8, 200.87, 3050 (modification) |
| DDT | 0.01 mg/kg | NR_19 | USEPA 8270/8081, acetone/hexane extraction |

| Parameter | Limit of Reporting | AGAL Method ID No. | Method Description |
|---|---|---|---|
| DDD | 0.01 mg/kg | NR_19 | USEPA 8270/8081, acetone/hexane extraction |
| DDE | 0.01 mg/kg | NR_19 | USEPA 8270/8081, acetone/hexane extraction |
| Aldrin | 0.01 mg/kg | NR_19 | USEPA 8270/8081, acetone/hexane extraction |
| Dieldrin | 0.01 mg/kg | NR_19 | USEPA 8270/8081, acetone/hexane extraction |
| Chlordane | 0.01 mg/kg | NR_19 | USEPA 8270/8081, acetone/hexane extraction |
| Heptachlor | 0.01 mg/kg | NR_19 | USEPA 8270/8081, acetone/hexane extraction |
| HCB | 0.01 mg/kg | NR_19 | USEPA 8270/8081, acetone/hexane extraction |
| Lindane | 0.01 mg/kg | NR_19 | USEPA 8270/8081, acetone/hexane extraction |
| BHC | 0.01 mg/kg | NR_19 | USEPA 8270/8081, acetone/hexane extraction |
| PCBs | 0.01 mg/kg | NR_19 | USEPA 8081 GC-ECD, GCECD |

AGAL is NATA-accredited for all of the above analyses.

## 2.3 Environmental Guidelines Grading and Compliance Procedure

Schedule 2 of the N.S.W. EPA *Environmental Guidelines* specifies the procedure for grading biosolids. An in-depth examination of this procedure is beyond the scope of this study, however a few important requirements of the guidelines should be noted:

- For batch sampling at domestic STPs, one sample per 100 dry solid tonnes, with a minimum of three samples per batch is required;
- The concentrations listed in Table 3-1 of the *Environmental Guidelines* are **not** mean concentration values. For batch sampling, the contaminant concentration (Q) is calculated as a function of batch mean (m) and standard deviation (s), as shown below:

  $$Q = m + a \times s$$

  Where ‘a’ is defined by the sample size, according to Table S2-1 in the *Environmental Guidelines.*

Table S2-1 (from *Environmental Guidelines*)

| **No. of Samples** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|---|
| Coefficient, a | 2.00 | 1.92 | 1.85 | 1.80 | 1.76 | 1.73 | 1.71 | 1.68 |

Hence, the larger the sample size and the longer the sampling history, the lower the calculated batch mean.

- Determination of the standard deviation is based on long-term estimates of the variation within batches. This procedure is specified in section 2.2.1 of Schedule 2; and
- When data is reported at below the detection limit, half the value of the detection limit should be used in contaminant grade calculations.

For the purposes of this report, the grading and compliance procedure recommended under Schedule 2 of the *Environmental Guidelines* has been adopted. In all cases, 3 composite samples were collected for each solid waste. No other historical sampling data was available at any of the facilities. Hence, to compare the analytical results of this study against the N.S.W. EPA *Environmental Guidelines*, the Contaminant Concentration, Q, for each solid waste was calculated by:

$$\mathbf{Q = m + 2 \times s}$$

where

m = mean of 3 collected solid waste samples

s = sample standard deviation of 3 collected solid waste samples

Therefore, since ($2 \times s$) encompasses 68% of all normally distributed data, Q actually represents the concentration under which 84% of samples could be expected to fall.

# 3. Review of Biosolids Regulations

## 3.1 Other Australian Biosolids Guidelines

Presented in this section is a brief summary of the contaminant thresholds published in other national biosolids management guidelines. For a more comprehensive review of the various regulations in force around Australia, the reader is referred to the Queensland EPA's discussion paper[1].

In general, the various frameworks adopted by each state are similar in that the classification process is based upon both contaminant and stabilisation grading. However, there is some variation in the number of tiers/grades adopted by each state. For this study only contaminant concentration thresholds were examined.

Shown in Table 3 and Table 4 are the contaminant concentration threshold criteria for unrestricted use and land application, respectively.

**Table 3 Contaminant Criteria for Unrestricted Use Products**

| **Contaminant (mg/kg)#** | **Nat.** (grade C1) | **NSW** (grade A) | **Vic** (grade C1) | **SA** (grade A) | **Tas** (grade A) | **WA** (grade C1) | **Qld** (grade A) (proposed) |
|---|---|---|---|---|---|---|---|
| Arsenic | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Cadmium | 1 | 1 | 1 | 3 | 3 | 3 | 1 |
| Chromium | 100-400 | 100 | 400 | - | 100 | 100 | 100 |
| Copper | 100 | 100 | 100 | 200 | 100 | 100 | 100 |
| Lead | 150-300 | 150 | 300 | 200 | 150 | 150 | 150 |
| Mercury | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Nickel | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| Selenium | 3 | 5 | 3 | - | 5 | 3 | 5 |
| Zinc | 200 | 200 | 200 | 250 | 200 | 200 | 200 |
| DDT/DDD/DDE | 0.5 | 0.5 | 0.5 | - | 0.5 | 0.5 | 0.5 |
| Dieldrin & other OC pesticides ^ | 0.02-0.05 | 0.02 | 0.05 | - | 0.2 | 0.02 | 0.02 |
| PCBs | 0.05-0.3 | N.D.* | 0.05 | - | 0.3 | 0.3 | 0.05 |

Source: Qld EPA, (November 2001). *Discussion Paper for Beneficial Use of Specified Organic Wastes.*

* N.D. – non-detectable at detection limit of 0.2 mg/kg

# Values are expressed on a dry weight basis

^ Other OC pesticides include – aldrin, chlordane, heptachlor, HCB, lindane, BHC

**Table 4 Maximum Contaminant Thresholds for Land Application**

| Contaminant (mg/kg)# | Nat. | NSW | Vic | SA | Tas | WA | Qld (proposed) (Grade C) |
|---|---|---|---|---|---|---|---|
| Arsenic | 60 | 30 | 60 | 20 | 20 | 60 | 20 |
| Cadmium | 20 | 32 | 10-20 | 11 | 20 | 20 | 20 |
| Chromium | 500-3000 | 600 | 3000 | - | 500 | 500 | 500 |
| Copper | 2500 | 2000 | 2000 | 750 | 1000 | 2500 | 2000 |
| Lead | 420 | 500 | 500-840 | 300 | 420 | 420 | 420 |
| Mercury | 15 | 19 | 5-15 | 9 | 15 | 15 | 15 |
| Nickel | 270 | 300 | 270 | 145 | 270 | 270 | 270 |
| Selenium | 50 | 90 | 50 | - | 50 | 90 | 50 |
| Zinc | 2500 | 3500 | 2500 | 1400 | 2500 | 2500 | 2500 |
| DDT/DDD/DDE | 1 | 1 | 1 | - | 1 | 1 | 1 |
| Dieldrin & other OCs | 0.5 | 1 | 0.5 | - | 0.5 | 0.5 | 0.5 |
| PCBs | 0.5 | 1 | 0.5 | - | 1 | 0.5 | 1 |

Source: Qld EPA, (November 2001). *Discussion Paper for Beneficial Use of Specified Organic Wastes.*

# Values are expressed on a dry weight basis

It can be seen from Table 3 that the proposed Queensland contaminant thresholds mirror the N.S.W. guideline values (with the exception of PCBs). However, the proposed Queensland maximum thresholds for land application uses are more conservative then the N.S.W. equivalents.

It must also be noted that the N.S.W. *Environmental Guidelines* relate to the "land application and disposal of biosolids derived from sewage treatment plants" [2] only, whereas the proposed Queensland strategy is aiming to encompass all organic solid wastes.

## 3.2 Proposed Queensland Guidelines

In Table 27 of its *Discussion Paper* [1], the Queensland EPA summarises its recommended regulatory model for organic waste management at **abattoirs and rendering plants**. The key elements of this model are:

- Sampling for heavy metals to follow N.S.W. guidelines;
- Sampling for OCs and PCBs required once only;

- Sampling for pathogens – yet to be determined (more information required);
- Sampling for nutrients to follow MRC publication, *Abattoir Wastewater and Odour Management*;
- Sampling frequency to be **one sample every 1000 dry solid tonnes**; and
- Classification process to be based on mean comparison with absolute threshold values.

This model is still open for comment in the EPA's *Discussion Paper.* For the purposes of this study, the contaminant concentrations (Q) of the solid waste samples collected at the four processing facilities will be compared against the Grade A contaminant acceptance concentration thresholds of the N.S.W. EPA *Environmental Guidelines*. However, as illustrated above, these are the same values proposed for adoption by the Queensland EPA (with the exception of PCBs).

# 4. Results

GHD undertook solid waste sampling at four meat processing facilities in south-east Queensland, on the following dates:

- Processing Facility No.1 6 August 2002;
- Processing Facility No.2 8 August 2002;
- Processing Facility No.3 15 August 2002; and
- Processing Facility No.4 16 August 2002.

Summarised in Table 5 below are the mean contaminant concentrations calculated according to the method described in section 3 ($Q = m + 2 \times s$). The types of solid waste identified were:

| | |
|---|---|
| Paunch; | Biosolids from belt filter press; |
| Screenings; | Lairage manure; |
| Anaerobic pond scum; | Composted organic waste; and |
| DAF float material; | Save-all sludge. |

The **bold** values in Table 5 are those that exceed the Grade A contaminant concentration threshold of the N.S.W. EPA *Environmental Guidelines.* Note that where analytical results for all three replicates of a solid waste stream were reported below the detection limit, the result is shown in the table as "< D.T.", where D.T. is the corresponding detection limit. Where an individual result was recorded as below the detection limit, but either or both of the other replicates were reported above the detection limit, half the value of the detection limit has been used to calculate the mean contaminant concentration, as per the requirements of the *Environmental Guidelines*.

Also shown are the mean values for total solids, volatile solids and pH for each type of solid waste.

The results in Table 5 are also displayed graphically in Figures 1 – 11. These 3-D figures illustrate the specific contaminant concentration (Q) for each solid waste at each processing facility. Graphs for the organic contaminants DDT, DDD, DDE, aldrin, heptachlor, HCB, lindane, BHC and PCBs are omitted because **all** analyses were reported as below detection limit.

Attached in Appendix A are the raw analytical data from the AGAL laboratory. Attached in Appendix B are Excel spreadsheet summaries of all the analytical results and the calculations for contaminant concentrations (Q). This is arranged such that there is one spreadsheet for each processing facility.

Three solid waste samples were reanalysed – screenings sample No.1 from Processing Facility No.3 (retested for zinc only), screenings sample No.2 from Processing Facility No.3 (retested for copper only) and save-all sludge sample No.2 from Processing Facility No.2 (retested for As, Cd, Cr, Cu, Pb, Hg, Ni, Zn, TS and VS). These particular samples and analyses were selected for retesting because it was noted that they were significantly different from the other two replicates collected for these solid waste streams.

All of the reanalysed solid waste samples (with the exception of the copper analysis on the save-all sludge sample) returned results that were more consistent with the other replicates and hence were adopted in this report. The retested copper analysis on the save-all sludge sample was rejected because it was significantly different from the other replicate results.

**Table 5 "Mean" Contaminant Concentrations (Q) for Replicated Solid Waste Samples**

| Waste Type | Paunch | | | | Screenings | | | BFP Cake | | Manure | | DAF | Save-all | Scum | Compost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Facility No.** | **1** | **2** | **3** | **4** | **1** | **3** | **4** | **1** | **2** | **2** | **4** | **2** | **2** | **3** | **3** |
| Arsenic (mg/kg) | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 | 1.31 | 2.20 | < 0.5 | < 0.5 | 0.83 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Cadmium (mg/kg) | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | 0.22 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 | < 0.2 |
| Chromium (tot) (mg/kg) | 3.02 | 12.77 | 2.31 | 3.50 | 5.48 | 5.63 | 7.49 | 25.82 | 23.49 | 15.05 | 8.49 | 9.15 | 56.45 | 2.68 | 1.49 |
| Copper (mg/kg) | 25.44 | 6.27 | 5.76 | 11.69 | 24.75 | 7.30 | 22.69 | **130.0** | 82.76 | 29.20 | 22.44 | 8.15 | 34.66 | 36.36 | 2.37 |
| Lead (mg/kg) | 0.30 | 2.44 | < 0.2 | < 0.2 | 1.18 | 0.82 | 0.48 | 4.06 | 4.95 | 2.44 | 0.49 | 0.85 | 4.19 | 0.78 | 1.05 |
| Mercury (mg/kg) | < 0.01 | < 0.01 | 0.04 | 0.04 | < 0.01 | 0.05 | 0.06 | < 0.01 | 0.04 | < 0.01 | 0.04 | < 0.01 | 0.07 | 0.06 | 0.03 |
| Nickel (mg/kg) | 1.47 | 5.93 | 0.61 | 2.24 | 2.89 | 2.24 | 4.70 | 15.49 | 14.82 | 27.52 | 14.52 | 3.40 | 20.41 | 1.64 | 1.04 |
| Selenium (mg/kg) | 1.23 | 1.31 | < 0.5 | < 0.5 | 1.48 | < 0.5 | < 0.5 | 3.34 | 3.30 | < 0.5 | 0.70 | 1.49 | 0.80 | < 0.5 | < 0.5 |
| Zinc (mg/kg) | 193.9 | 40.98 | 110.9 | 77.95 | 145.6 | 30.00 | 95.71 | **330.0** | **310.0** | 106.8 | 107.3 | 82.72 | 115.89 | 61.35 | 26.68 |
| DDT (mg/kg) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| DDD | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |

| **Waste Type** | **Paunch** | | | | **Screenings** | | | **BFP Cake** | | **Manure** | | **DAF** | **Save-all** | **Scum** | **Compost** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Facility No.** | **1** | **2** | **3** | **4** | **1** | **3** | **4** | **1** | **2** | **2** | **4** | **2** | **2** | **3** | **3** |
| (mg/kg) | | | | | | | | | | | | | | | |
| DDE (mg/kg) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Aldrin (mg/kg) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Dieldrin (mg/kg) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | 0.011 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Chlordane (mg/kg) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | **0.038** | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Heptachlor (mg/kg) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| HCB (mg/kg) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Lindane (mg/kg) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| BHC (mg/kg) | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| PCBs (mg/kg) | < 0.02 | < 0.01 | < 0.01 | < 0.01 | < 0.02 | < 0.01 | < 0.01 | < 0.02 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 | < 0.01 |
| Tot. Solids (% d.s) | 22.30 | 20.70 | 30.73 | 24.17 | 19.43 | 29.20 | 26.17 | 10.47 | 13.73 | 45.33 | 21.23 | 24.87 | 27.63 | 85.43 | 83.80 |
| Vol. Solids (%d.s.) | 90.43 | 86.53 | 97.83 | 92.27 | 95.00 | 91.37 | 68.27 | 83.17 | 76.40 | 38.67 | 88.80 | 94.67 | 63.87 | 69.07 | 60.47 |

| **Waste Type** | **Paunch** | | | | **Screenings** | | | **BFP Cake** | | **Manure** | | **DAF** | **Save-all** | **Scum** | **Compost** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Facility No.** | **1** | **2** | **3** | **4** | **1** | **3** | **4** | **1** | **2** | **2** | **4** | **2** | **2** | **3** | **3** |
| pH | 6.77 | 7.63 | 5.30 | 6.77 | 6.43 | 6.27 | 6.67 | 6.43 | 6.60 | 8.47 | 6.90 | 5.57 | 5.60 | 6.73 | 5.93 |

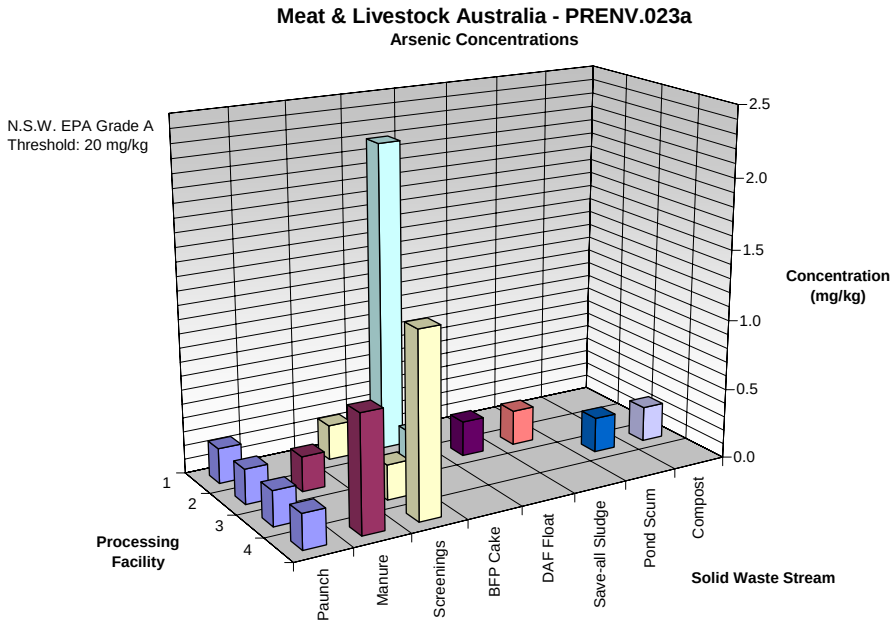


**Figure 1 Arsenic Concentrations**

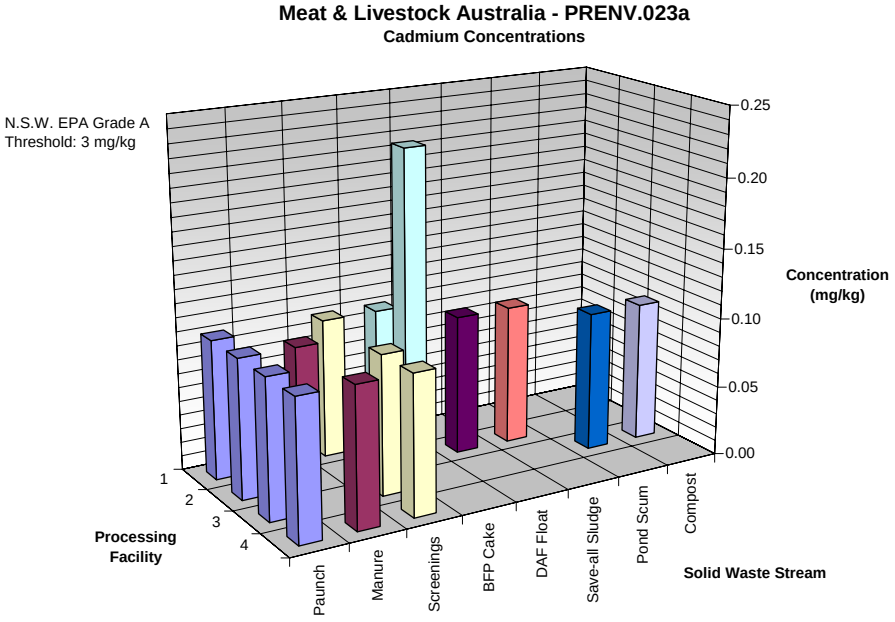

**Figure 2 Cadmium Concentrations**

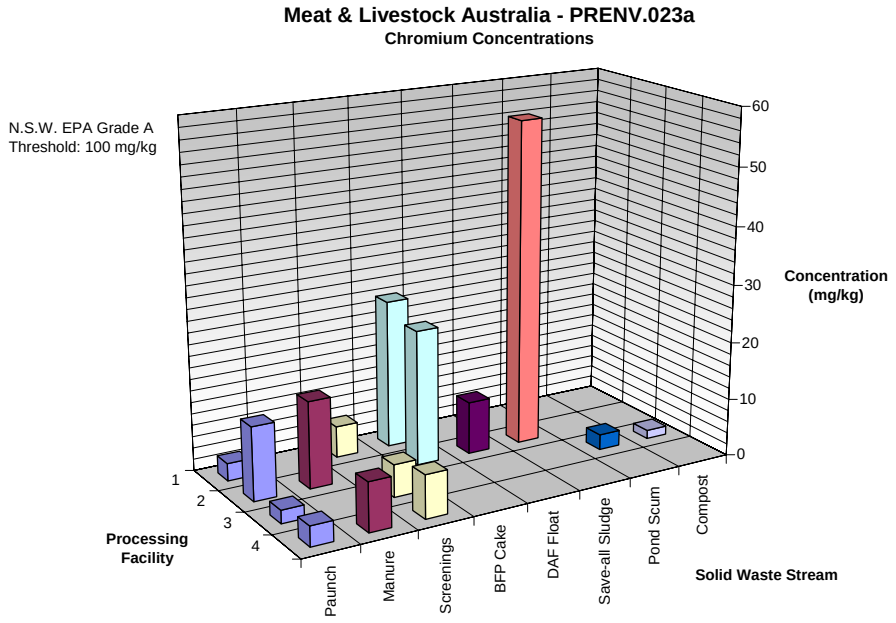


**Figure 3 Chromium Concentrations**

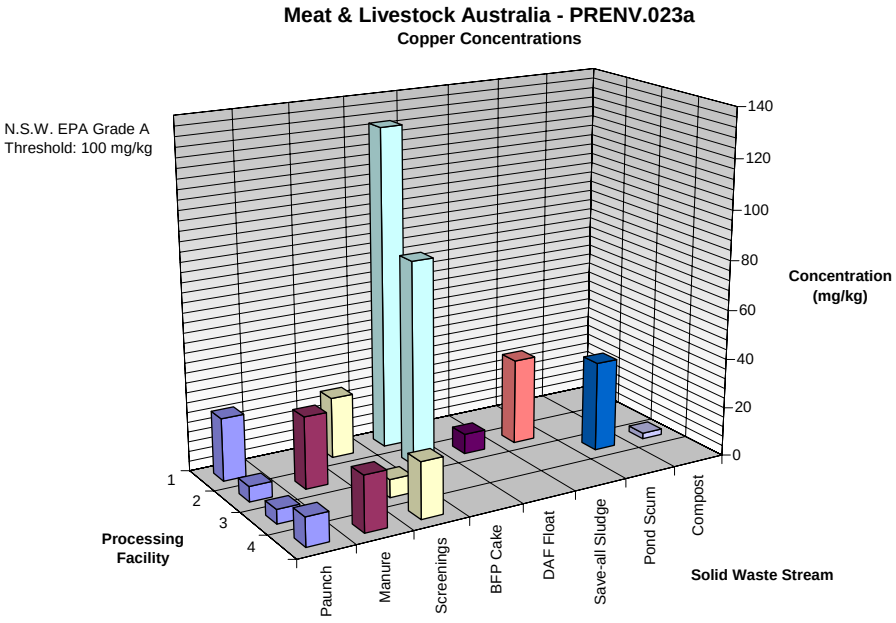

**Figure 4 Copper Concentrations**

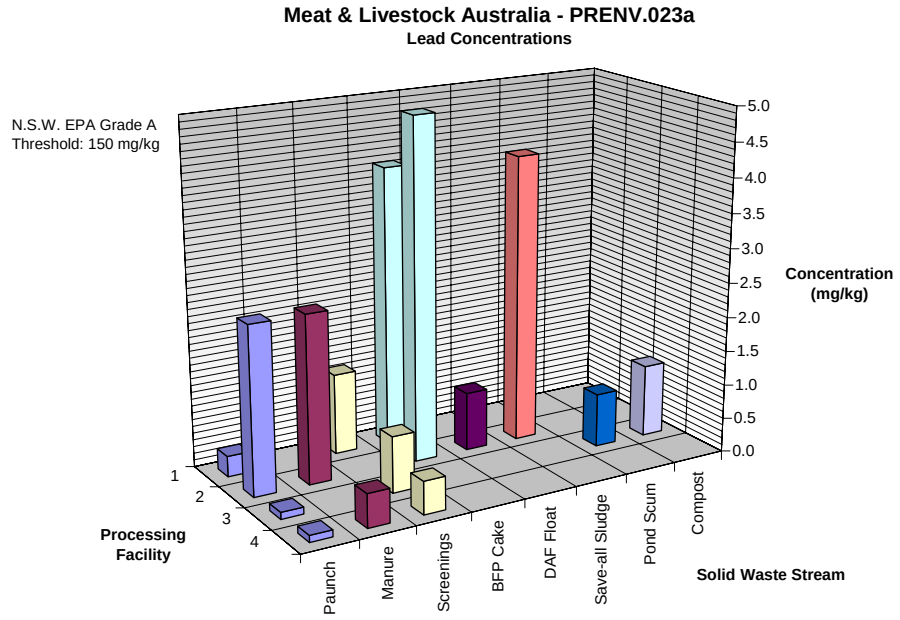


**Figure 5 Lead Concentrations**

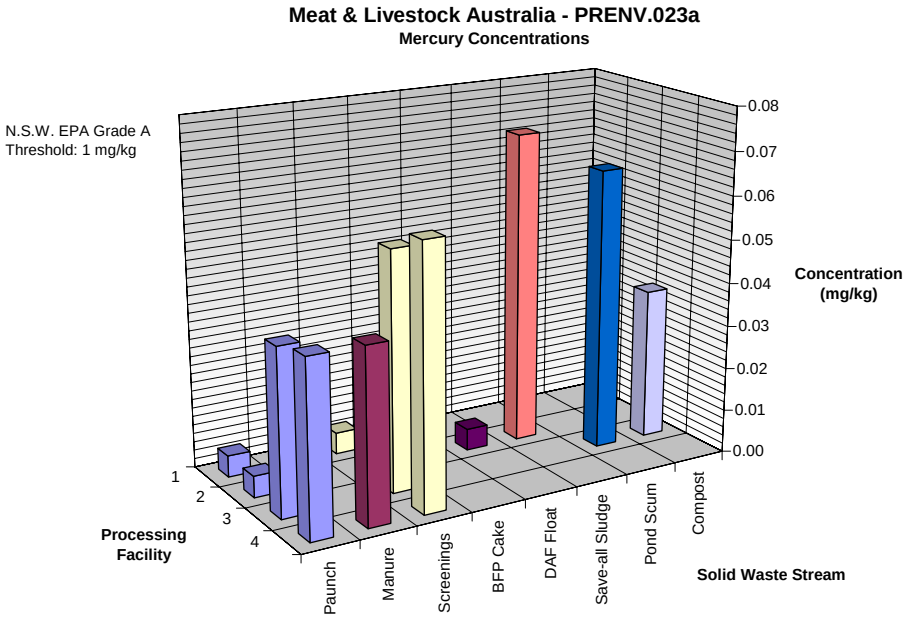

**Figure 6 Mercury Concentrations**

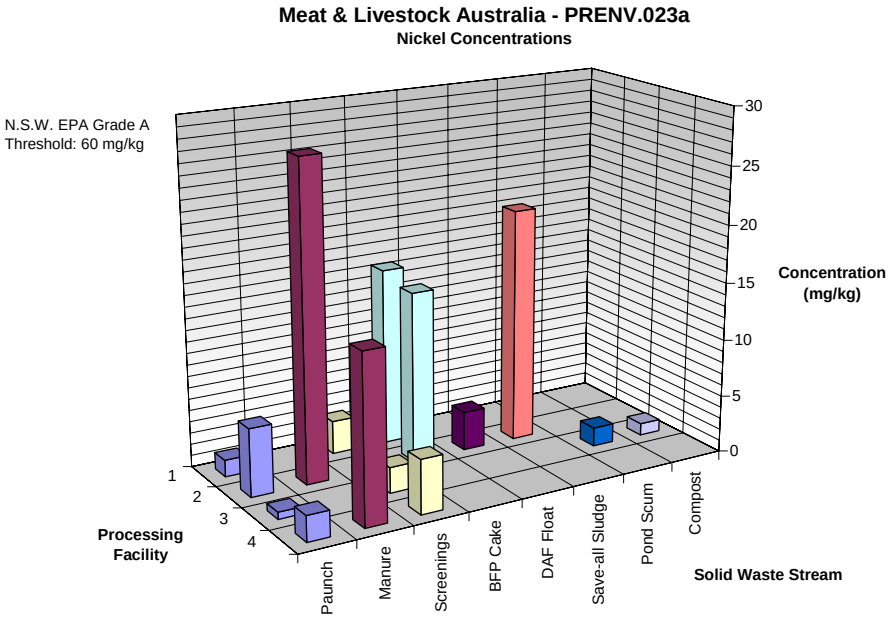


**Figure 7 Nickel Concentrations**

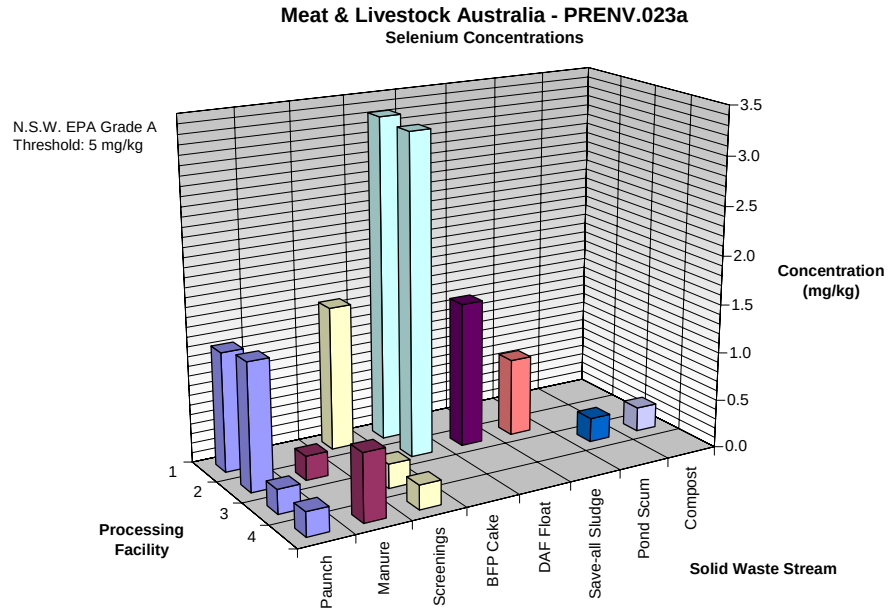

**Figure 8 Selenium Concentrations**

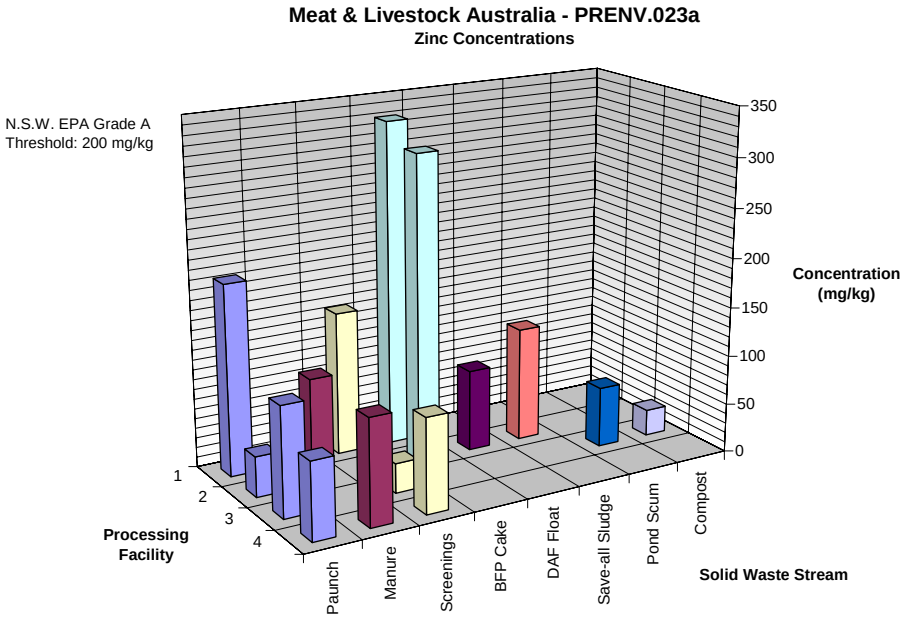


**Figure 9 Zinc Concentrations**

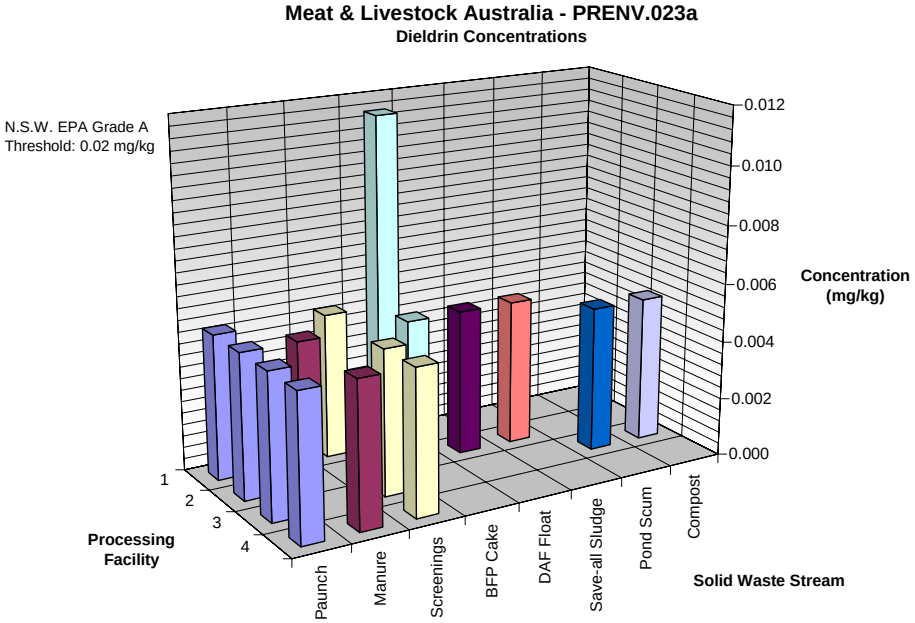

**Figure 10 Dieldrin Concentrations**

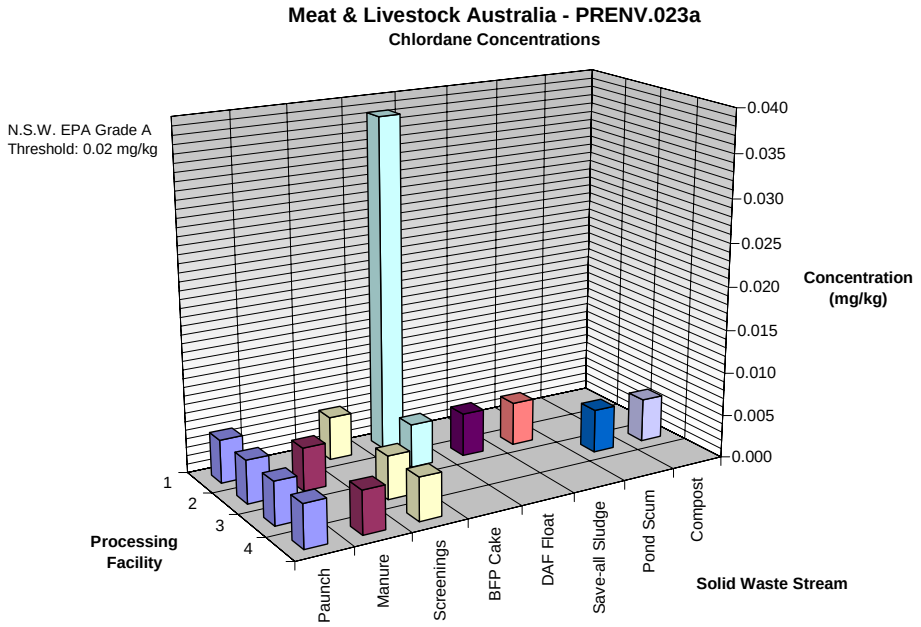


**Figure 11 Chlordane Concentrations**

# 5. Discussion

## 5.1 Heavy Metal Concentrations

The results presented in Table 5 show that all 15 of the solid waste streams easily met the N.S.W. *Environmental Guidelines* Grade B heavy metal thresholds. Furthermore, 13 of the 15 solid waste streams satisfied all the Grade A thresholds.

The N.S.W. *Environmental Guidelines* requires testing for nine heavy metals, as outlined in Table 2. For seven of these heavy metals, all the solid waste types were shown to be below the Grade A threshold. Concentrations of copper and zinc in excess of the Grade A threshold were found in only two of the 15 solid waste streams.

High zinc contaminant concentrations were detected in 2 solid waste samples (BFP cake at Processing Facilities Nos. 1 and 2). Elevated readings were also detected in the screenings and paunch at Processing Facility No.1. This indicates that there may be an identifiable cause behind such readings. For example, galvanised pipelines and equipment, or flaking of zinc-based paints may contribute to these elevated zinc concentrations. These issues may require further investigation by MLA.

A high copper concentration was also detected in the BFP cake at Processing Facility No.1. This was an isolated incident with no other solid waste samples registering above the Grade A threshold limit. Whilst the large number of copper pipes and fittings in meat processing plants may suggest that high copper concentrations could be an issue, the fact that only one solid waste sample registered above the Grade A threshold limit implies that the problem may be limited to Processing Facility No.1 only. Biological treatment does concentrate metals in the biosolids produced. In addition, the corrosivity of water supplies to copper pipe can vary greatly between different locations. It could be that the water supply to Processing Facility No.1 is more corrosive than at the other facilities. This issue may require further investigation
by MLA.

As mentioned in section 4, three samples were reanalysed because of concerns over heavy metal concentrations in one of the replicates.

The concentration of chromium in the save-all sludge collected at Processing Facility No.2 is also a concern. As discussed in section 2.3, the calculation of the contaminant concentration (Q) is dependent upon sample mean and standard deviation. The complete analytical results attached in Appendix B show that for the three samples collected from the save-all sludge, Sample No.2 was significantly higher (100 mg/kg on first analysis, 41 mg/kg on second analysis) than the other two samples (14 mg/kg, 7.3 mg/kg). Consequently, this data set had a high mean and high standard deviation and hence a high contaminant concentration (Q).

Given the low chromium levels recorded in all other solid waste samples at this and all the other processing facilities, it is possible that the high chromium concentration recorded for save-all sludge sample No.2 is due to sampling or analytical error. The solid waste samples are very heterogenous.

Other potential sources of contamination are flaking of chromium-based paint on the save-all or corrosion of stainless steel equipment (e.g. cooling tower) and/or fittings.

## 5.2 Organic Contaminant Concentrations

The results presented in Table 5 illustrate that in almost all cases the reported organic contaminant concentrations were below the laboratory detection limit. The following contaminants registered below detection limit in all solid wastes at all facilities:

- DDT;
- DDD;
- DDE;
- Aldrin;
- Heptachlor;
- HCB;
- Lindane; and
- PCBs.

Furthermore, all 15 solid waste streams reported organic contaminant concentrations below the N.S.W. *Environmental Guidelines* Grade B thresholds. Organic contaminant concentrations for 14 of the 15 solid waste streams were below the Grade A thresholds.

The one solid waste sample of concern was the high chlordane concentration recorded for the belt filter press cake at Processing Facility No.1. All other solid waste samples at this and the other processing facilities recorded chlordane concentrations below the laboratory detection limit. This suggests some particular residual contamination at Processing Facility No.1 and should be investigated further.

Chlordane has been widely used in Australia as a pesticide (on crops such as corn and citrus fruits) and as a termiticide. Its use in the United States was banned in 1988 and it is listed as a toxic chemical under the *Emergency Planning and Community Right-to-Know Act*[4]. In Australia, the use of chlordane continued until 30 June 1995[5], before being banned because of the hazard posed to human health and the environment.

Chlordane is very persistent in the environment. It adsorbs strongly to soil particles and is not likely to enter the groundwater. It also known to strongly bioaccumulate in fish and other aquatic organisms[6]. It is probably significant that chlordane was detected in this facility, which processes the highest proportion of grain-fed beef.

Given the highly persistent nature of this chemical and the serious risk it poses to human and environmental health, MLA should consider further investigating its detection in the belt filter press cake of Processing Facility No.1.

There were two other irregularities that need to be mentioned.

[4] www.nsc.org/library/chemical/chlordan.html, 8 September 2002.

[5] Peters, B.C., J. King, F.R. Wylie. (2001). "Treating subterranean termite attacks in buildings", *Queensland Department of Primary Industries Note*, www.dpi.gov.au/forestry/4999.html, 8 September 2002.

[6] Agency for Toxic Substances and Disease Registry, www.atsdr.cdc.gov/tfacts31.html, 22 August 2002.

Firstly, the PCB limit of detection was different for the first processing facility investigated. For Processing Facility No.1, the limit of detection was 0.02 mg/kg.

For the other processing facilities, the limit of detection was 0.01 mg/kg (as reported in Table 2). However, all PCB analyses registered below the stated detection limit and were below the 0.2 mg/kg detection limit required in the N.S.W. EPA *Environmental Guidelines*.

AGAL has advised that the elevated detection limit for PCB analyses at Processing Facility No.1 was due to the high moisture content and other interferences in the samples.

Secondly, the belt filter press cake at Processing Facility No.1 recorded a dieldrin concentration slightly above the detection limit of 0.01 mg/kg, but still below the Grade A contaminant threshold of 0.02 mg/kg. This result suggests that there may be some residual organic contamination at this particular facility. Similar to the heavy metals, any residual organics present will be concentrated into the biosolids from a biological treatment process. All other solid waste samples at this and the other processing facilities recorded dieldrin concentrations below the laboratory detection limit.

# 6. Conclusion

In response to recent moves by the Queensland Government to review its position on organic solid waste management, MLA commissioned GHD to undertake project PRENV.023a – *Assessment of Contaminants in Waste Solids from Meat Processing Wastewater Streams*. This project involved collecting solid waste samples from four meat processing facilities for laboratory analysis of heavy metals and organic contaminants (e.g. organochlorine pesticides and PCBs).

Sample collection, analysis and grading were undertaken in accordance with the requirements of the N.S.W. EPA *Environmental Guidelines* [2]. All solid waste streams were sampled in triplicate, with the calculated contamination concentration (Q) compared against the Grade A contaminant threshold limits of the N.S.W. *Environmental Guidelines*.

In summary, this project has demonstrated that 13 of the 15 solid waste streams sampled comply with the Grade A heavy metal and organic contaminant thresholds outlined in the N.S.W. *Environmental Guidelines*. Coupled with a Stabilisation Grade A, these solid wastes would be classified “Unrestricted Use”, suitable for home lawns and gardens, as per the criteria outlined in Table 3-6 of the *Environmental Guidelines*.

Only 2 solid waste samples (BFP cake from Processing Facilities Nos. 1 and 2) did not meet the Grade A thresholds for the following contaminants:

- Zinc concentrations were above the Grade A threshold limit in the BFP cake of Processing Facilities Nos. 1 and 2;
- The copper concentration in the BFP cake at Processing Facility No.1 was above the Grade A threshold limit; and
- The chlordane concentration in the BFP cake at Processing Facility No.1 was above the Grade A threshold limit.

In all three cases, the recorded contaminant concentrations were well below the Grade B thresholds. Hence, coupled with a Stabilisation Grade A, these solid wastes would be classified “Restricted Use 1”, suitable for public contact sites, urban landscaping and agricultural land application.

MLA should consider further investigation of these results, in consultation with the relevant processing facilities. In particular, the high chlordane reading should be thoroughly investigated to determine if there is an identifiable source.

Appendix A

# AGAL Analytical Data

Processing Facility No.1 – 21 August, 2002

Processing Facility No.2 – 23 August, 2002

Processing Facilities Nos.3 and 4 – 2 September, 2002

Appendix B

# Summary of Analytical Data (Excel spreadsheet)

Processing Facility No.1 – 6 August, 2002

Processing Facility No.2 – 8 August, 2002

Processing Facility No.3 – 15 August, 2002

Processing Facility No.4 – 16 August, 2002

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