ACT Government
Transport Canberra and City Services

# FREEDOM OF INFORMATION COVERSHEET

The following information is provided pursuant to section 28 of the *Freedom of Information Act 2016*.

FOI reference: TCCSFOI 2018-085

| Information to be published | Status |
|---|---|
| 1. Access application | Published |
| 2. Decision notice | Published |
| 3. Documents and schedule | Published |
| 4. Additional information identified | No |
| 5. Fees | n/a |
| 6. Processing time (in working days) | 119 days |
| 7. Decision made by Ombudsman | n/a |
| 8. Additional information identified by Ombudsman | n/a |
| 9. Decision made by ACAT | n/a |
| 10. Additional information identified by ACAT | n/a |

RECEIVED
DATE 1/10/18 BY TCCS

18-085

**From:** [redacted]
**Sent:** Monday, 1 October 2018 1:25 PM
**To:** TCCS_FreedomOfInformation
**Subject:** Canberra Times freedom of information request - NoWaste

To the FOI contact officer,

I write under the Freedom of Information Act 2016 to request the following documents in the possession of the Transport Canberra and City Services Directorate:

- all emails between Adam Perry of Capital Recycling and ACT NoWaste director Michael Trushell in 2016
- All meeting notes of meetings between Adam Perry of Capital Recycling and ACT NoWaste director Michael Trushell in 2016
- All third party reports handed to government about waste-to-energy, burning rubbish, waste incinerators etc from 2015 to 1 October 2018
- All ministerial briefs related to waste-to-energy, burning rubbish, waste incinerators etc from 2015 to 1 October 2018

The object of freedom of information laws is to make the people and bodies that are responsible for governing the territory more accountable to the public.

The release of these documents would satisfy provisions 2.1 (a) (i), (ii), (iii),(v), (vi), (viii), (x) and (xi) of the Freedom of Information Act 2016.

I can be contacted on [redacted] to discuss the scope of my request if required.

[redacted]

m [redacted]
www.canberratimes.com.au

**The Canberra Times**

ACT Government
Transport Canberra and City Services

[redacted]

Dear Ms [redacted]

**Freedom of Information Request - Reference 18-085**

I refer to your application made under the *Freedom of Information Act 2016* (the Act), which was received by Transport Canberra and City Services Directorate (TCCS) on 1 October 2018, in which you sought copies of documents in procession of TCCS as follows:

1. all emails between Adam Perry of Capital recycling and ACT NoWaste director Michael Trushell in 2016
2. all meeting notes of meetings between Adam Perry of Capital Recycling and ACT NoWaste director Michael Trushell in 2016
3. all third-party reports handed to government about waste –to-energy, burning rubbish, waste incinerators etc. from 2015 to 1 October 2018
4. all ministerial briefs related to waste-to-energy, burning rubbish, waste incinerators etc. from 2015 to 1 October 2018.

I have numbered each part of your request for ease of reference.

I am an Information Officer appointed by the Director-General under section 18 of the Act to deal with access applications made under Part 5 of the Act.

TCCS was required to provide a decision on your access application by 29 October which was extended by 15 days due to third party consultation to 19 November 2018. I apologise for the delay in providing a response and thank you for your patience by providing time extensions for this request.

**Decision on access**

I have identified 13 documents that fall within the scope of your request amounting to 189 pages of information.

The documents contain information that I consider to be, on balance, contrary to the public interest to disclose under the test set out in section 17 of the Act.

I have decided to grant access, under section 50 of the Act, to the documents with deletions applied to information that I consider would be contrary to the public interest to disclose.

I have included at Attachment A to this decision the schedule of relevant documents. This provides a description of each document that falls within the scope of your request and the access decision for each of the documents.

**Statement of Reasons**

In reaching my access decision, I have taken the following into account:

The Act, in particular:

**Factors favouring disclosure**

- Schedule 2.1 (a) (i) promote open discussion of public affairs and enhance the government's accountability
- Schedule 2.1 (a) (ii) Contribute to positive and informed debate on important issues of matters of public interest
- Schedule 2.1 (a) (viii) reveal the reason for a government decision and any background or contextual information that informed the decision.

**Information disclosure of which is taken to be contrary to the public interest**

- Schedule 1.6 (a) Cabinet information that has been submitted, or that a Minister proposes to submit to cabinet for its consideration and that was brought into existence for that purpose

**Factors favouring nondisclosure in the public interest**

- Schedule 2.2(a) (i) prejudice the protection of an individual's right to privacy or any other right under the *Human Rights Act 2004*;
- Schedule 2.2 (a) (xi) prejudice trade secrets, business affairs or research of an agency or person;
- Schedule 2.2 (a) (xiii) prejudice the competitive commercial activities of an agency;
- Schedule 2.2 (a) (xv) prejudice the management function of an agency or the conduct of industrial relations by an agency;
- Schedule 2.2 (a) (xvi) prejudice the deliberative processes of government.

Waste-to-energy and the development of a Territory policy is topical. It is the subject of a community engagement project listed on the ACT government's *Your Say* website. This supports the public interest disclosure of information about waste-to-energy as it could enhance open discussion of public affairs. Public release of information could contribute to positive and informed debate on this matter. In this respect, there is clear public interest in release of information that you have requested.

**Part 1**

Two documents have been identified under Part 1 of your request. In the interests of pro-disclosure and open government (Section 9 of the FOI Act) I have decided to release these documents to you. I have redacted information that may prejudice the protection of an individual's right to privacy. The information redacted covers contact details and information about a person's movements and release of this information would prejudice an individual's right to privacy.

**Part 2**

There were no documents identified under Part 2 of your request.

**Part 3**

Part 3 of your request seeks third party reports provided to government about waste–to-energy, burning rubbish, waste incinerators etc. from 2015 to 1 October 2018. Three reports were identified and were received as part of the ACT Feasibility study.

The reports do not necessarily represent the views of government but were provided to government as part of waste feasibility studies used to understand the capacity and capabilities of the waste industry to deliver resource recovery solutions in the ACT. The waste feasibility study informed government as documented in public reports such as the *Waste Feasibility Study Roadmap and Recommendations Discussion Paper* prepared by ACT NoWaste in May 2018 (documents can be found on the *Your Say* website).

Following third party consultation, I have decided to release these documents to you in full.

**Part 4**

There are six ministerial briefings identified falling within the scope of your request.

***General discussion***
Several of the briefing documents provide information which directly underpinned the deliberative process of government and that contain information that was submitted, or a Minister proposed to submit to Cabinet for its consideration and that were brought into existence for that purpose. The documents deal with the ACT Waste Feasibility study and market sounding and propose the development of a waste-to-energy policy. Cabinet documents, or documents brought into existence for submission to Cabinet, is considered information, the disclosure of which is taken to be contrary to the public interest under Schedule 1.6.

I have considered these documents carefully.

On the one hand they were all brought into existence or submitted to Cabinet for its consideration and on that basis are taken to be, contrary to the public interest to release.

On the other hand, the outcome of Cabinet's deliberations on these matters are on the public record and the decision public[1].

In this case, I gave attention to the fact that the decision has been made and the waste-to-energy consultation project and policy development exercise is in the public arena as is the waste feasibility study paper. The waste-to-energy consultation and relevant documents as agreed by Cabinet can be found at the *Your Say* website (https:/www.yoursay.act.gov.au).

I have decided that knowledge about a cabinet submission and the outcome of those deliberations is no longer information that can be taken to be contrary to the public interest under schedule 1.6 (Cabinet information) because of its publicity. Nonetheless, the briefings include deliberative material, including options, that were considered by Cabinet in coming to its decision. Such deliberative information remains Cabinet information and as a result, I have removed deliberative statements and discussion as they are not in the public interest to release as Cabinet information or, alternatively, information that under factor (a) (xvi) could prejudice the deliberative processes of government.

***Document 7 (referenced in the schedule at Attachment A)***

This brief provides information to the Minister following a Canberra Times article on 21 July 2017 on a proposal by Capital Recycling Solutions (CRS) to develop a recycling and waste-to-energy plant at Fyshwick.

The document contains information about the business affairs of CRS that may be prejudicial to their business. There is also information contained in the brief which, if released, could prejudice the management function of NoWaste specifically its relationship with waste industry providers. I have decided that it would be contrary to the public interest to release such information.

I have also removed material which is highly speculative about possible future scenarios because it may prejudice deliberative processes of government and impact negatively on those processes if public servants could not be candid with a Minister.

***Document 8***

Document 8 is a briefing seeking the Minister's agreement on the preliminary findings of the Waste Feasibility Study and presentation of those findings to the Economic Development Subcommittee of Cabinet. This document is deliberative and is the basis of matters which were considered by Cabinet.

I applied my reasoning as outlined above and decided that it is in the public interest to understand the processes followed by government in making decisions. As the outcomes of that deliberation are now public, that is, the findings and roadmap have been released, I have decided that the brief is in the public interest to release. I note however it is a deliberative brief and may not represent the final decisions of government.

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[1] Open Access – Cabinet decision summary for the week of 24 September 2018.

***Document 9***

Document 9 is a briefing to the Minister in relation to two letters written by Mr Rattenbury. One of these letters was to the government in Mr Rattenbury's capacity as an ACT Greens member and the other letter was in Mr Rattenbury's ministerial capacity as Minister for Climate Change and Sustainability and advice from his portfolio Directorate: Environment, Planning and Sustainable Development (EPSD).

In relation to information provided about Mr Rattenbury's letter as a Green's member, I have decided to release this information as it outlines the Green's policy position on waste management and waste-to-energy. The analysis is limited, appropriately extending only to explanation of the facts as understood by government, for example, inconsistency with the parliamentary agreement in relation to the waste hierarchy contained in the Green's policy.

I have redacted much of the discussion concerning comments made by another agency. These comments are related to the waste-to-energy Cabinet submission and form part of cabinet deliberations. In addition, I have removed information directly related to recommendations to Cabinet from this assessment. The release of such information is covered under Schedule 1.6 as information that has come into existence for the purpose of Cabinet consideration and disclosure is taken to be contrary to the public interest.

***Document 10***

Document 10 is a briefing to the Waste Manager about the Capital Recycling Solutions (CRS) draft Environmental Impact Statement (EIS). It seeks the Waste Manager's signature to a letter making representations to the Chief Planning Executive. I have decided that the information contained in the Brief and attached letter are largely in the public interest to release. This includes information about the business affairs of CRS which I believe are on the public record such as applications for development that were open for public comment. I have however removed some information relating to CRS and a related company which is sensitive and not in the public interest to release as it may be prejudicial to the business affairs of these companies.

***Document 11***

Document 11 is a briefing to the Minister for Transport and City Services proposing the preparation of a cabinet submission recommending community consultation and the development of a policy position on waste-to-energy.

The background to this brief contained a large amount of factual and publicly known information about waste-to-energy. I considered whether the information formed part of deliberations and found that it does not. It merely presents an evidentiary basis for the proposal for a policy. In this respect, the information falls outside the Cabinet information exclusion.

I considered each element of the information and factors that supported nondisclosure in the public interest such as state and commonwealth relations. For example, I found that the outcome from the Environment Minister's meeting on 27 April 2018 mentioned in the brief is reflected in the Environment Minister's meeting communique and is therefore public information.

I have decided that the public interest is heavily weighted in favour of release of the background material contained in document 11.

Redactions have however been made to the *Issues* section of document 11 where the information is deliberative and developed in anticipation for submission to Cabinet (schedule 1.6). This includes removal of the project plan including attachment A to the brief and the project scope and overview at attachment D to the brief. The Minister's feedback at folio 168 refers to information in attachment D and has also been redacted as being information taken to be contrary to the public interest to release.

I have also removed feedback from *Consultation* as it relates to options proposed to Cabinet.

Attachment B (Towards a sustainable Canberra 2011-2015 Strategy) and Attachment C (Waste Feasibility Study and Roadmap and Discussion paper) of document 11 are public documents and have not been considered in the request for information under section 45 (a) of the FOI Act.

***Document 12***

I have redacted in full document 12 and the attached cabinet documents as information not in the public interest to release. The brief was brought into existence for submission of a proposal to cabinet for consideration. There is factual information in this document and the attached draft cabinet submission, but it cannot be redacted without revealing Cabinet's deliberations. I note however that the factual information is contained in earlier briefings where it is not part of the deliberations and thus available to you in these briefings.

My decision is to redact the brief and attachments in full under the Cabinet exclusion contained in schedule 1.6 (a).

**Charges**
I have decided to waive fees as the matter at this time is of special benefit to the public.

**Online publishing – disclosure log**
Under section 28 of the Act, TCCS maintains an online record of access applications called a disclosure log. Your original access application, my decision and documents released will be published in the TCCS disclosure log from 3 days after the date of this decision. Your personal details will not be published.

You may view TCCS' disclosure log at www.tccs.act.gov.au/about-us/freedom_of_information.

**Ombudsman review**
My decision on your access request is a reviewable decision as identified in Schedule 3 of the Act. You have the right to seek an Ombudsman review of this outcome under section 73 of the Act within 20 working days from the day that my decision is published in TCCS' disclosure log or a longer period allowed by the Ombudsman.

If you wish to request a review of my decision, you may write to the Ombudsman at:

The ACT Ombudsman
GPO Box 442
CANBERRA ACT 2601

Via email: actfoi@ombudsman.gov.au

**ACT Civil and Administrative Tribunal (ACAT) review**
Under section 84 of the Act, if a decision is made under section 82(1) on an Ombudsman review, you may apply to the ACAT for review of the Ombudsman decision.

Further information may be obtained from ACAT at:

ACT Civil and Administrative Tribunal
Level 4, 1 Moore Street
GPO Box 370
CANBERRA CITY ACT 2601
Telephone: (02) 6207 1740
www.acat.act.gov.au

If you have any questions concerning the directorate's processing of your request, or would like further information, please contact the directorate's FOI Coordinator on 6205 5408 or email tccs.foi@act.gov.au.

Yours sincerely

Ben McHugh
Information Officer

27 March 2019

ACT Government
Transport Canberra and City Services

**Attachment A**

# Freedom of Information - SCHEDULE

Please be aware that under the *Freedom of Information Act 2016*, some of the information provided to you will be released to the public through the ACT Government's Open Access Scheme.

Personal information or business affairs information will not be made available under this policy. The Open Access release status column of the table below indicates what documents are intended for release online through open access. If you think the content of your request has been accessed incorrectly and could contain personal or business affairs information please notify the FOI Officer immediately by email TCCS_freedomofinformation@act.gov.au

Information about what is published on open access is available online at: http://www.tccs.act.gov.au/about-us/freedom_of_information

| File reference no | |
|---|---|
| TCCS FOI 18-085 | NoWaste documents |

| Document Ref no | No of folios in document | Type of document | Date on Document | Access Status | Reason for non-release or deferral (folio No) | Open access release status |
|---|---|---|---|---|---|---|
| 1 | 1 | Email – Trushell and Perry | 7 October 2016 | Partial | Schedule 2.2(a) (i) prejudice the protection of an individual's right to privacy or any other right under the *Human Rights Act 2004* | yes |
| 2 | 2-3 | Email – Perry and Thorman | 25 November 2016 | Partial | Schedule 2.2(a) (i) prejudice the protection of an individual's right to privacy or any other right under the *Human Rights Act 2004* | yes |
| 3 | 4-53 | Air Burners – Better Economically Better environmentally | | Full release | | yes |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | 54-77 | Ektimo – Firebox Emission Testing report | 2 May 2016 | Full release | | yes |
| 5 | 78-102 | Mike Lyons & Associates - Feasibility Study | 2 may 2016 | Full release | | yes |
| 6 | 103-150 | Submission<br>MRA Consulting Group - Technical Summary of energy from Waste | 3 July 2018 | Full release | | yes |
| 7 | 151-153 | Ministerial brief – B17-124 – Capital recycling solutions recycling and waste-to-energy Plant | 21 July 2017 | Partial | Schedule 2.2 (a) (xi) prejudice trade secrets, business affairs or research of an agency or person;<br>Schedule 2.2 (a) (xv) prejudice the management function of an agency or the conduct of industrial relations by an agency;<br>Schedule 2.2 (a) (xvi) prejudice the deliberative processes of government. | yes |
| 8 | 154-158 | Ministerial Brief B17/174 – ACT Waste Feasibility study status update and market sounding outcomes | 24 July 2017 | Partial | Schedule 2.2 (a) (xvi) prejudice the deliberative processes of government.<br>Schedule 1.6 (a) Cabinet information | yes |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 | 159-164 | Ministerial brief B17/285 – ACT Greens Waste Policy framework | 16 July 2017 | Partial | Schedule 1.6 (a) Cabinet information | yes |
| 10 | 165-167 | Deputy Director-General brief and attachment 167(A) DGBR18/130 – Waste manager representation to Capital Recycling Solutions Draft EIS | 16 May 2018 | Partial | Schedule 2.2 (a) (xi) prejudice trade secrets, business affairs or research of an agency or person | yes |
| 11 | 168-173 | Ministerial Brief – B18/196 – Waste-to-Energy (WtoE) policy in the ACT – forward plan | 12 June 2018 | Partial | Schedule 2.2 (a) (xvi) prejudice the deliberative processes of government.<br>Schedule 1.6 (a) Cabinet information | yes |
| 12 | 174-189 | Ministerial Brief – CS18/407 – Waste-to-Energy policy | 7 September 2018 | Non-release | Schedule 1.6 (a) Cabinet information | No |

**Trushell, Michael**

**From:** Adam Perry [redacted]
**Sent:** Friday, 7 October 2016 5:10 PM
**To:** Trushell, Michael
**Cc:** [redacted]
**Subject:** Re: Landfilling options

Thanks Michael,

I look forward to catching up to discuss our proposal, hopefully late next week or during the week after next. I shall be in touch soon.

Regards
Adam

Adam Perry
Access Recycling
[redacted]
P: [redacted]
M: [redacted]
[redacted]

On 7 Oct 2016, at 16:37, Trushell, Michael <Michael.Trushell@act.gov.au> wrote:

Good afternoon Adam

Thank you for taking my call, it was good to talk with you. When convenient please let me know when you would be available to meet to discuss opportunities around landfilling.

Regards,

Michael

**Michael Trushell | Director**
**Phone 02 6207 2840** | Email: Michael.Trushell@act.gov.au | **Mob** [redacted]
**ACT NOWaste** | Transport Canberra and City Services Directorate | **ACT Government**
12 Wattle Street, Lyneham | GPO Box 158 Canberra ACT 2601 | www.act.gov.au

**Trushell, Michael**

**From:** Adam Perry [redacted]
**Sent:** Friday, 25 November 2016 7:49 AM
**To:** Thorman, Rob
**Cc:** Trushell, Michael
**Subject:** RE: Catch up next Wednesday [SEC=UNCLASSIFIED]

Good morning gents, I have the [redacted] meeting at 1pm. Could do before or after that.. [redacted]

*Adam Perry*
*Director*
*Access Recycling*

[redacted]

ACCESS RECYCLING SERVICES

**From:** Thorman, Rob [mailto:Rob.Thorman@act.gov.au]
**Sent:** Wednesday, 23 November 2016 5:16 PM
**To:** Adam Perry [redacted]
**Cc:** Trushell, Michael <Michael.Trushell@act.gov.au>
**Subject:** Catch up next Wednesday [SEC=UNCLASSIFIED]

Adam
Thanks for your time on the phone today. I have spoken with Michael and he is keen to meet with you next Wednesday (Nov 30). He has an appointment finishing about 1.30 but is free for most of the afternoon, if you want to suggest a time that fits in with your schedule.
Regards Rob

Phone 62053062
[redacted]

# Preferred Options for the Closure of the West Belconnen Resource Management Centre (WBRMC)

Options paper prepared by Rob Thorman for the Directorate Cluster Group

21 December 2016

## Contents

## 1 Introduction

Key functions of the West Belconnen Resource Management Centre (WBRMC) will need to cease by the end of 2019 and alternatives found in order to allow for land release as part of the Ginninderry project. The ACT Government has committed to complete this work as part of its contribution to the development joint venture (West Belconnen Joint Venture Agreement 2011). After several years of preliminary investigations, the lead times involved require that decisions are now made on which final options will be selected.

It needs to be recognised that that ACT Government is losing a valuable resource with the planned closure of the WBRMC. For example the WBRMC has provided a $15M cost benefit to the ACT Government in recent years alone by providing a cost effective and practical option for demolition waste from Mr Fluffy homes. Ideally a new site should be found that provides immediate access to cost effective ACT based emergency landfill capacity.

Government needs to be aware of this cost as a result of the proposed development when considering potential alternative options, in addition to the need to fund site rehabilitation.

Current functions of the WBRMC are shown in **Figure 1** and include:

- A potential emergency landfill site for general waste
- The Canberra Sand and Gravel operations which includes a green waste drop off, the composting facility and sales of landscape supplies. The composting facility will need to be removed from its current location in the short term
- Parkwood Road Recycling Estate, managed by ACT Property Group which will have its leases progressively cease. Property Group currently plan for leaseholders to be fully evicted by the end of 2020, which would then be followed by full remediation
- Demolition waste from Mr Fluffy homes and other asbestos disposal which is scheduled to be phased out by mid to late 2018, and after that will go to the Mugga Lane Resource Management Centre (MLRMC)
- The WBRMC Recycling Drop Off Centre (RDOC) which is scheduled to be closed with the public redirected to the other four northside RDOC facilities.
- Operational soil stockpiles which is subject to a separate work being undertaken by ACT NOWaste
- Land farming. This is the provision of clay (or other suitable impermeable material) bunded pads to facilitate a biological remediation processes to attenuate contaminating substances in soils, until the soils are at an accepted level of contamination for disposal into an approved landfill disposal area.

This paper recommends priority areas for action in the short term to allow estate development and land release to proceed in relation to:

- Alternative arrangements for emergency landfill
- Alternatives to the current CSG composting facility
- Rehabilitation of the site.

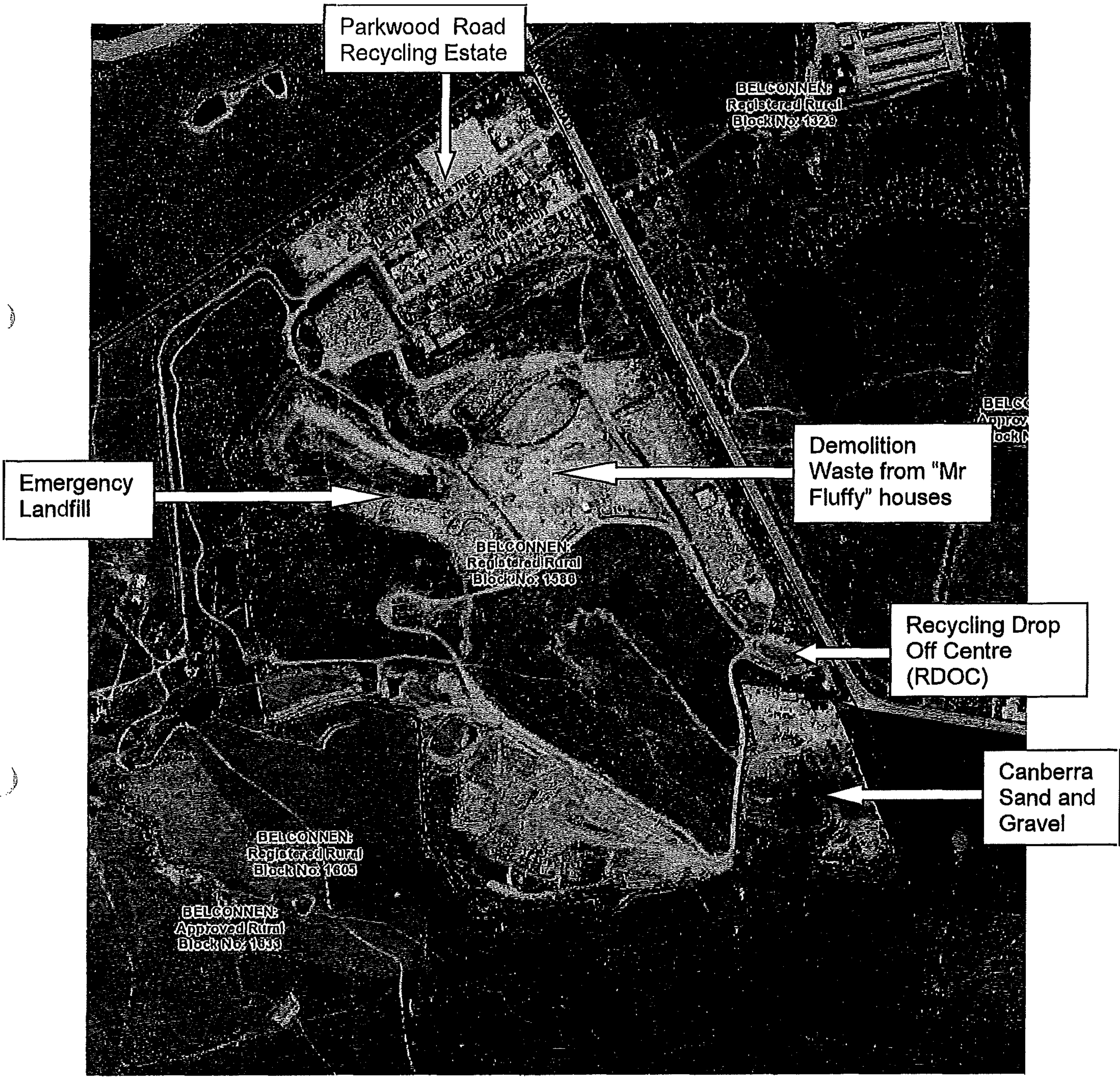



**Figure 1 West Belconnen Resource Management Centre and location of key functions**

## 2 Progress of the West Belconnen Steering Committee

The Steering Committee held its third meeting on 21 December.

The Committee worked through an earlier version of this options paper and proposed action plan. The committee:

- Noted that a range of options have previously been identified and that a refined set of options is being pursued.
- Agreed that the preferred set of options should be further progressed towards implementation, noting that in a significant emergency waste it is proposed that waste be transported across the border into NSW.
- Noted the cost implications and indicative budget for closure of the WBRMC, and that further work is required to estimate costs of alternative options.
- Agreed that subject to suggested amendments the Options Paper should be presented to the Directorate Cluster Group meeting on 21 December.

The Steering Committee also went on a site visit with staff from the Ginninderry Joint Venture to better understand the operations of the site and the timing and budget required to close and rehabilitate the site.

**Figure 2 West Belconnen Steering Committee and Ginninderry reps on site**

## 3 Emergency landfill

### Site selection process

A range of potential options for an emergency landfill (ELF) site have been presented and outlined in previous documents, including work by CBRE and subsequent analysis by the Ginninderry Joint Venture (refer to **Appendix A**).

The Environment, Planning and Sustainable Development Directorate previously indicated it did not support any options in Kowen or to the east of the Airport, in order to keep future planning option open.

Further analysis of options identified in **Appendix A** has been undertaken since early November. Criteria for assessing appropriate emergency landfill options have included:

- Practical and cost effective solutions
- Consistency with long term planning objectives
- Timeframe over which an alternative capacity may be needed
- Response time – ability to activate within 1-4 hours
- Continuity of service for customers delivering waste
- Whether all waste streams need to be diverted or only part diversion required.

As a result of further assessment and consultation with agencies and industry, a number of possible options identified earlier have been excluded from further assessment. Some options such as the Eaglehawk quarry were clearly inappropriate being so close to existing housing, and some of the other options suggested are still operational quarries. However, many of the options listed in **Appendix A** are still being further considered to play at least part of an emergency response, as discussed further below. These include Mugga Lane RMC, Mugga 2, West Belconnen, Woodlawn, Windellema, Access Recycling at Fyshwick, and sites around Fairbairn/ Pialligo for a soil bank.

These consultations have also helped identify some additional sites that are now being assessed in more detail. Sites in Hume, the area surrounding the Queanbeyan Sewage Works, Mitchell, and the Majura Valley may also be able to provide a site for waste to be transferred in the event of an emergency.

### What constitutes an emergency?

Possible emergencies and potential responses are outlined in a Risk Matrix in **Appendix B**. Depending on its seriousness, a range of approaches would be required to respond to an escalating emergency situation.

- **Short term emergency or loss of capacity**

This could be a disruption of one or two days in a defined area such as the active tip face (for example a police investigation or landfill fire in a confined area), or a shortfall in available capacity (eg delays in cell construction or approvals). This would involve directing around 700 tonnes of waste per day to an alternative part of the Mugga Lane Resource Management Centre (RMC) landfill area (within Stage 5) See **Figure 3**. Critical to this response is timing the funding and construction of additional landfill capacity ahead of time, to enable ongoing management flexibility.

The landfill area within Mugga Lane RMC is large enough that with advance planning spare capacity could be retained in other areas of Stage 5. The advantage of this approach is that the spare capacity will ultimately be used, as new capacity is created. In this way the additional long term cost of providing emergency capacity is minimal, although it does require funding for landfill construction to be brought forward as well as guaranteed ongoing funding to ensure that this additional forward capacity is always maintained.

Riggall and Associates (2015) have suggested that contractual requirements could be included for the contractor to provide emergency landfill options at the site in the event of short term or moderate emergency. Subject to agreement by the Directorate Cluster Group to the overall approach proposed in this paper, discussions would be held with the operator Remondis about roles and responsibilities and any contractual obligations.

Part of the short term response may also involve holding waste back temporarily, for example in the case of industrial action where collection of household waste has been delayed for a day or two.

- **Moderate emergency**

This would be where closure of the Mugga Lane RMC landfill area (stage 5) is required for a period of a week or more (for example a more extensive landfill fire, or release of toxins). This would assume that around 5,000 tonnes of waste would need to be stockpiled in a separate area within the Mugga Lane RMC. This option would require a clay pad to be constructed with an alternative access road away from the current Stage 5 landfill area (See **Figure 3**).

During the emergency the piles would be covered with earth or tarps overnight. Litter fencing would also be required. Once the immediate emergency is over, this stockpile of waste would be transferred to the active landfill cell.

To determine the dimension of the clay pad, Riggall and Associates 2015 have estimated an area of 100m x 50m with a 3m lift provides 15,000 cubic metres of landfill volume, or up to 3 weeks capacity. More detailed design work would be required to determine necessary access areas, drainage, and leachate and odour management.

This option will require access to weighbridge facilities and critical pavement improvements, potentially including road access upgrades to ensure safe entry and exist to the site. Safe access to various parts of the Mugga Lane RMC becomes an even greater imperative with the closure of West Belconnen RMC in that all short term and moderate emergencies are reliant on secure access into the Mugga Lane RMC from Mugga Lane.

The preferred location for this facility is currently being used for stockpiling excavated material from construction of the new landfill cell. This option therefore requires further investigation to determine required landform and to manage the stockpile as a priority. The subsequent beneficial reuse of the stockpile is currently being investigated by Procurement Capital Works and TCCS Capital Works.

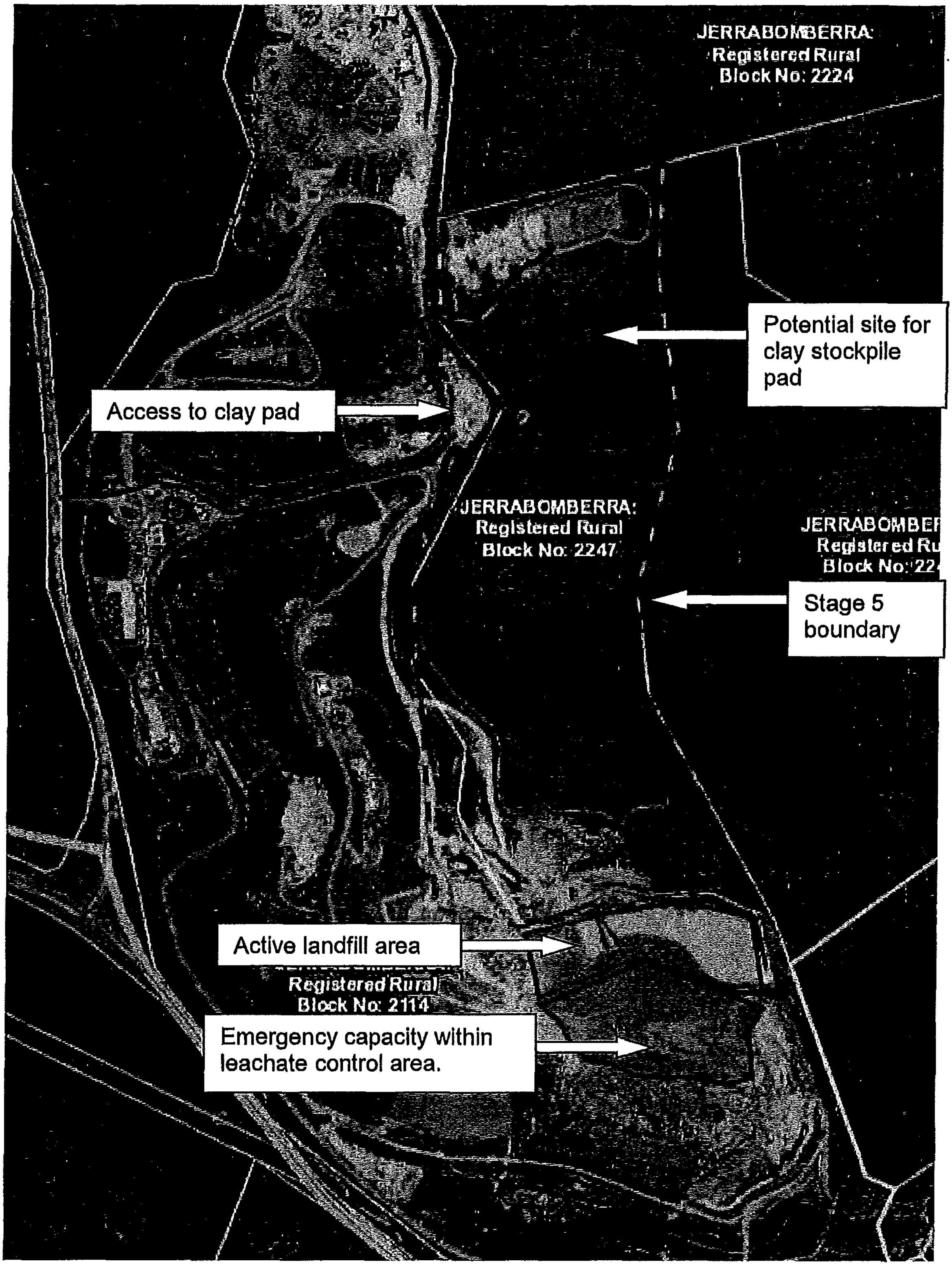



**Figure 3** **Mugga Lane Resource Management Centre**

- **Significant emergency**

This could include an extended closure of Mugga Lane RMC Stage 5 landfill area that would be beyond the capacity of the stockpile area developed elsewhere in the Mugga Lane RMC for a moderate emergency, or an event that prevented access to the entire Mugga Lane RMC for an extended period of up to a month or more. Closure of the entire Mugga Lane RMC for a short period, such as a bushfire moving through the area, could partially be accommodated by working with industry to delay delivery of waste, and delaying household waste collection for a day or two.

Depending on the extent of the emergency, this would trigger a transfer of up to 20,000 tonnes a month away from the Mugga Lane RMC.

The Boral quarry further north along Mugga Lane has been considered but this is currently an active quarry, and would be best considered as a future landfill opportunity once the quarrying has been completed, possibly in 20 – 25 years time.

Depending on the seriousness of the emergency, the most suitable option identified is to transport waste into NSW to the Veolia facility at Woodlawn. This could require one or more transfer facilities away from the Mugga Lane RMC for transport by either road or rail. Options are being investigated with potential industry partners and the Planning Directorate for:

- Rail transfer from Fyshwick
- Provision of transfer facilities for transport by truck. This would require capacity for around 35 truck movements per day (at 20 tonnes each). Locations being assessed include Hume, Mitchell and West Belconnen, potentially associated with existing or potential regional drop off facilities and transfer stations. Sites are also being investigated adjacent to the Queanbeyan Sewage Treatment plant or in the Majura Valley. It is likely that an Environmental Impact Statement would need to be prepared for many of these sites.

Diversion of waste out of the ACT will require different site options for different waste streams. Woodlawn will accept general and putrescible waste, but will not accept construction and demolition waste including asbestos. In an emergency it may be possible to work with industry to delay or hold some construction and demolition waste at construction sites, or to stockpile some of this waste in other locations in the ACT. This could potentially include the Mugga 2 Quarry, further north from the Mugga Lane RMC, in consultation with the NCA. Discussions are also being held with industry for an alternative site in NSW at Windellema that is licensed to take these waste streams including asbestos.

Discussions have been held with NSW EPA, NSW Planning, Goulburn Mulwaree Council and Queanbeyan-Palerang Regional Council about transport and disposal of waste in NSW in the event of an emergency (refer to **Appendix D**). The most significant issue identified to date is the possible need to modify licences to vary the amount of waste that can be accepted. For example the Environment Protection Licence for Woodlawn includes a 50,000 tonne limit per annum for putrescible regional waste received by road. This licence could be modified to allow for an additional 130,000 tonnes of regional waste in agreement with NSW Planning if a number of criteria are met. Discussions have commenced in this regard.

It is important to note that some waste operators are already set up to transport waste interstate, and if these extreme circumstances were to eventuate, operators could be required to make their own commercial arrangements for transport and disposal of waste interstate, avoiding double handling. During a significant emergency additional flexibility could allow for domestic bin waste collection to be postponed. With reduced collection frequency it may be more possible for domestic trucks to deliver waste directly to Woodlawn during an emergency, or to existing transfer stations within NSW.

- **In summary**

The preferred option is where possible, in a short term or moderate emergency, waste disposal or temporary stockpiling would continue to occur within the Mugga Lane RMC where there is provision for leachate storage and treatment.

This would include ensuring that there is always capacity to be able to relocate the active tip face within the current landfill area, and to be able to temporarily stockpile waste on a clay pad for a limited time for landfilling at a later date.

Contractual requirements could be included for the contractor to manage the site to provide emergency landfill options in the event of short term or moderate emergency.

In the case of a significant emergency which forces the closure of the entire Mugga Lane RMC, agreements and material handling facilities will need to be in place to ensure waste can be transferred by road and rail to Woodlawn.

Actions required to implement these options are shown in **Table 2**.

Subject to general agreement by the Directorate Cluster Group to the approach proposed in this paper, more detailed feasibility and costing will be undertaken and progress reported at the next meeting.

## 4 Canberra Sand and Gravel

Canberra Sand and Gravel currently operate a facility that accepts garden green waste, a composting facility and an outlet for landscape supplies (location in **Figure 1**). The composting facility currently requires a precautionary 1,000 meter buffer, or exclusion zone in which residential development is not permitted. This would impact on the early stages of the proposed Ginninderry residential development.

Ginninderry have commissioned odour modelling work to assess the appropriate size of an exclusion zone and outcomes of this work will be available shortly.

A reduction in the exclusion zone would allow for some additional development to proceed, but this would only provide a short term solution. The composting facility will also need to be closed or moved to an alternative location.

A site suggested in the Crace grasslands as an alternative location for the Canberra Sand and Gravel composting facility has also been discounted by TCCS for a range of environmental and probity issues.

As an additional short term solution, this could potentially be within the Parkwood Road Recycling Estate, over 1 kilometre further to the north, noting that this option may incur additional relocation costs, including water supply infrastructure.

An assessment is also being carried out by Ginninderry on whether a number of appropriate land uses could be located within the buffer zone around the Lower Molonglo Water Quality Control Centre (LMWQCC) along Stockdill Drive. This could potentially include a composting facility.

In the longer term, a number of relevant issues are currently being addressed within Government that could impact on the relocation of this facility. These include:

- The upcoming market sounding from the Waste Feasibility Study, which is inviting industry to identify and propose emerging technologies that could more effectively process Canberra's various waste streams, including green waste.
- The introduction of Green Bins to collect garden waste, and potentially in the future include food waste, which may impact on location and method of processing.
- A proposed strategic approach to CSG operations and compliance at various locations in Fyshwick, Mitchell and West Belconnen. It must be noted that this approach would require commitment and a lead agency to take charge.

For these reasons, short term solutions to the location of the composting facility at West Belconnen are appropriate. Within the next 12 to 18 months, there will be more clarity about the future of green waste across the ACT and in the meantime development of the early stages of Ginninderry can proceed.

It is therefore recommended in the short term that a reduction is the exclusion zone is explored and that an alternative site for the composting facility is found within the Parkwood Road Recycling Estate, or within the buffer zone of the LMWQCC.

## 5 Mr Fluffy Demolition Disposal

The majority of Mr Fluffy demolitions are scheduled to be completed by mid to late 2018. The timeframe for the demolition of the final 40 or so houses is unknown at this point. Demolition waste from these houses will continue to go to WBRMC while it is still operational and from then on to Mugga Lane RMC.

## 6 Disposal of clean fill and certain construction and demolition waste

Planning for the closure of clean fill disposal at WBRMC has been underway for several years. Capital works are being undertaken at Mugga 2 (to the north of the Mugga Lane RMC) and final approvals are being sought from the National Capital Authority for the disposal of clean fill and certain types of construction and demolition waste (for example bricks, concrete and earth, but not organic matter including timber or carpet). It is expected that Mugga 2 will be able to take these waste streams by the time of the West Belconnen RMC closure.

## 7 Rehabilitating the site

The following tasks will be required to allow for closure and rehabilitation for the West Belconnen RMC by 2020:

- Determining what infrastructure will be removed and what will remain eg network of access roads
- Defining the final profile based on expected volumes of demolition waste to be received
- Modelling of location and depth of various types of buried waste, and any movement of contaminants
- Monitoring of gas and leachate
- Developing and implementing a closure and capping plan
- Refinement of landscape and drainage plan by Ginninderry based on above inputs, and desired end use.
- Implementing a rehabilitation plan for the entire site and after care management plan
- Site auditor determination of land use suitability for all areas of the site.

At its December 8 meeting the Steering Committee discussed the level of rehabilitation required. The current Master Plan for the site, which is a formal schedule to the Joint Venture Agreement, indicates buildings on areas that include buried waste and rubber tires. This would require a much more expensive level of rehabilitation than if these areas were just capped and grassed to meet standard EPA requirements. David Maxwell from Gininderry reported that the Master Plan is only indicative and that a revised Master Plan would reflect what would be logical to do. With more information we will be able to define what are "no go areas" and what might be grey areas. Areas that are found to be unsuitable for development may include not only former landfill sites, but also include areas likely to be subject to migration of landfill gas or leachate.

There was agreement that the Territory should be responsible to close the site and rehabilitate to the EPA standard for a closed landfill. If the developer wished to extend development into "grey areas", it would be done at their cost. Those decisions should ideally be made well in advance of the closure of WBRMC so that any previously buried material that needs to removed for land remediation can be disposed of at West Belconnen, rather than being transported to Mugga Lane or elsewhere.

## 8 Estimating the Budget

Development of the budget bid by ACT NOWaste for 2017/18 is well progressed. A risk management workshop has been held with Treasury which has helped inform and refine an indicative budget, which was presented to the Steering Group at the meeting on 8 December. A draft budget of about $18.5M through till 2020/21 includes estimates for closure and associated works and landfill gas bores (Attached in **Appendix C**).

This budget does not include clearance and remediation of the Parkwood Road Recycling Estate, gas migration, or any excavation of waste to achieve indicative land uses in the draft Master Plan. Beyond rehabilitation to an agreed landform, costs of final landscaping to achieve the desired end use will be the responsibility of Ginninderry.

The indicative budget does not include any estimates for costs of emergency landfill options, or any costs that may occur with the relocation of the CSG composting facility, or recurrent after care funding.

Subject to agreement by the Directorate Cluster Group to pursue the proposed options, further investigations and cost estimates will commence in early 2017 to be included in future budget bids. Progress on this work will be reported to future Directorate Cluster Group meetings.

A Budget Framework is provided in **Table 1** .

| | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | TOTAL |
|---|---|---|---|---|---|---|
| Installation of landfill gas bores | X | X | | | | |
| Relocate green waste Composting facility | ? | ? | | | | |
| Model location, type and extent of waste | | X | | | | |
| Plan infrastructure removal and determine final landform | | X | X | X | | |
| Closure and capping | | | X | X | X | |
| Clearance and remediation of Parkwood Estate | | | | ? | ? | |
| Alternative emergency landfill infrastructure | | ? | ? | ? | | |
| New West Belconnen Waste infrastructure | | | | ? | ? | |
| Recurrent after funding | | | | | | |
| **TOTAL** | | | | | | |

**Table 1 Budget framework for WBRMC closure and alternative ELF options**

X Indicative Budget estimates included in Appendix A
? Budget estimates to be developed in 2017

## 9 Action Plan

**Table 2 Actions and responsibilities**

| Task | Action required | Responsibility |
|---|---|---|
| **Emergency Land fill** | | |
| Mugga Lane RMC | Preferred option in short term to moderate emergency is to maintain operations at MLRMC.<br>• Ensure adequate access and capacity at all times to enable operational flexibility to accept putrescible and other waste materials. Treasury to guarantee adequate ongoing funding for additional landfill capacity, including critical pavement improvements.<br>• Develop clay pad within the northern areas of the Mugga Lane RMC (cell 9). Undertake design and costing of clay pad for temporary stockpile.<br>• Liaise with the Landfill operator about the practical implementation of these options<br>• Liaise with EPA about approval processes to process and export some of the Mugga Lane RMC stockpile material. | MT / JC<br>AH / RT<br>AH<br>AH |
| | Confirm with NCA regarding Mugga 2 for certain types of non putrescible waste. Approval is being sought for some bonded asbestos – but need to explore additional demolition for example Commonwealth properties and urban renewal sites. | AH / RT |
| Cross border | Continue discussions with Veolia on opportunities to receive general waste by road or rail to Woodlawn in case of a significant emergency | MT/RT |
| | Continue to explore options with Hiquality about transporting to Windellema some construction and demolition waste including asbestos in the case of emergency. | MT/RT |
| | Explore transport options and formalise agreements with Veolia and NSW Planning.<br>Continue to liaise with other NSW local Authorities ( EPA, Councils)<br>Explore options for Transfer stations for waste to trucks– including clay pad for transfer at sites such as Hume, adjacent to the Queanbeyan Sewage treatment plan, Majura Valley, Mitchell or West Belconnen. Liaise with industry about capacity to provide transport services in an emergency such as Cleanaway, Suez (Qbn), Sita. | MT/ RT<br>RT<br>RT / Planning |
| | Continue liaison with Access Recycling for potential rail transfer at Fyshwick (also) Rail Hume spur | MT/RT |

| Task | Action required | Responsibility |
| --- | --- | --- |
| | Explore needs for Transfer station and potential RDOC for West Belconnen | RT/ MT/ WFS/ Ginninderry |
| | Consider future options for a district facility at Mitchell relocating the existing plant with a new facility with a Transfer station | MT / Planning Directorate /WFS |
| | Undertake more detailed work on feasibility and costings for report to next Cluster Group Meeting | RT |
| **Move Canberra Sand and Gravel** | | |
| | Continue to work with Ginninderry and the EPA to determine if the exclusion zone can be reduced | RT / Ginninderry |
| | Assess feasibility of relocating composting facility to the Parkwood Road Recycling Estate, including provision of water. | RT/Ginninderry/ Property Group |
| | A lead agency nominated to liaise with other Directorates to address compliance issues with CSG. This could include taking a more strategic approach across multiple sites and exploring opportunities for rationalisation. | JC / Steering Committee to determine |
| | Monitor progress on the Expression of Interest as part of the Waste Feasibility Study market sounding to determine if a comprehensive and innovative approach can be taken to processing to green waste. | MT /RT /WFS |
| | Monitor the impact of the introduction of green bins on existing operators. | MT / RT |
| | Further investigate feasibility of composting facility close to LMWQCC, including liaison with ICON Water. | RT/ Ginninderry |
| **Rehabilitating the site (consistent with text??)** | | |
| | Monitoring gas and leachate | AH |
| | Modelling location and depth of existing buried waste | AH |
| | Leaseholders to be removed from Parkwood Road Recycling Estate by mid 2019 to allow for remediation | ACT Property |
| | Closure and capping plan and implementation based on estimated volumes to be received | AH |
| | Development of final master plan | Ginninderry |
| | Rehabilitation according to Master Plan | AH / RT Ginninderry |

MT = Michael Trushell AH=Anthony Haraldson JC= Jim Corrigan RT= Rob Thorman WFS= Waste Feasibility Study

# Appendix A Previous assessment of alternative options

Preliminary investigations of alternative emergency landfill options and possible locations for composting facilities has been under way for several years, particularly by the Ginninderry joint venture. This includes a CBRE Emergency Landfill Options Paper and other analysis. These options have been shortlisted to form the basis of this paper.

## Review of CBRE Emergency Landfill Options Paper

| | | | | |
|---|---|---|---|---|
| | | POSSIBLE | UNLIKELY | |
| | | | | |
| BORAL QUARRY JEIR | | | | Active quarry. Potential unknown. |
| CSIRO LANDS | | | | Rezoned urban |
| LAWSON NAVAL SITE | | | | Urban encroachment |
| EAGLEHAWK QUARRY | | | | NSW. Has potential. |
| MAJURA PINES / MAJURA VALLEY | | | | MTB area. Army and firing ranges |
| STROMLO BUSHFIRE SITE | | | | Mtn Bike Centre. Not suitable? |
| FAIRBAIRN PINES | | | | Airport<3km. |
| CANBERRA CONCRETE RECYCLERS | | | | Airport<3km |
| PIALLIGO OLD LANDFILL SITE | | | | Possible stockpiling site? |
| PIALLIGO QUARRY | | | | |
| SYMONSTON | | | | Endangered spp |
| BORAL QUARRY MUGGA ACT | | | | |
| DISUSED QUARRY MUGGA 2, ACT | | | | Subject to NCA approval |
| MLRMC MUGGA LANE, ACT | | | | Stockpiling. Landfarm on landfill cells. |
| CEMEX COOMA RD QUARRY, NSW | | | | Proximity Googong/Jerrabomberra? |
| TUGGERANONG PINES, ACT | | | | Proximity Theodore/Chisholm |
| WILLIAMSDALE QUARRY, NSW | | | | Distant. Query future resource avail. |
| INGLEDENE PINES, ACT | | | | Distant. Poor road access |
| WOODLAWN / WINDELLAMA | | | | |
| | | | | |
| | | POSSIBLE | UNLIKELY | |

THIS SUMMARY TABLE WAS PREPARED BY GINNINERRY JOINT VENTURE FOR THE SEPTEMBER 2016 STEERING GROUP MEETING - BASED ON A CBRE REPORT PREVIOUSLY COMMISSIONED BY GINNIDERRY.

Waste Infrastructure

Transition Period to 2019

(assumes new sites not available due to lead time)

| Function | MLRMC | Boral Quarry | Mugga 2 | WBRMC | Woodlawn / Access Recycling | Fairbairn | Old Landfill (Pialligo) | New sites (eg Kowen) |
|---|---|---|---|---|---|---|---|---|
| General Waste | [redacted] | [redacted] | | | [redacted] | | | |
| Loose fill asbestos | [redacted] | | | | | | | |
| Asbestos contaminated building materials (10) | [redacted] | | [redacted] | [redacted] | | [redacted] | | |
| Soils (ACM) etc | | | [redacted] | | | | | |
| Emergency (putrescible) | | [redacted] | | [redacted] | [redacted] | | | |
| Emergency (other general waste) | | [redacted] | | [redacted] | [redacted] | | | |
| Land farming | [redacted] | | | [redacted] | | [redacted] | [redacted] | |

1. Boral has signalled interest – set up a cell if and when required ... use as emergency site until needed
2. Contractual agreement to be activated if Boral unavailable (bushfire / other) ... could be annual costs of availability?
3. Establish dedicated cell south of asbestos cell post 2019 (medium to high construction cost – drainage, lining) or include in general waste area
4. Possibility subject to NCA zone change to accept "hazardous material"?
5. Possibility to set up cell (see (1) above)
6. Contractual agreement – availability cost? Transport logistics.
7. Possible site (establishment costs?)
8. Possible site (ownership, lower establishment costs?)
9. Temporary sites at MLRMC (flat tops on interim landfill cells)
10. Not needed if materials are fully decontaminated as part of demolition (as per waste feaso recommendations)
11. Possible restrictions? Transport logistics.

FURTHER TEMPORAL ANALYSIS UNDERTAKEN BY GINNINDERRY JOINT VENTURE PRIOR TO THE OCTOBER 2016 STEEING COMMITTEE MEETING

Post 2019

| Function | MLRMC | Boral Quarry | Mugga 2 | WBRMC | Woodlawn / Access Recycling | Fairbairn | Old Landfill (Pialligo) | New sites (eg Kowen) |
|---|---|---|---|---|---|---|---|---|
| General Waste | [redacted] | [redacted] | | | [redacted] | | | [redacted] |
| Loose fill asbestos | [redacted] | | | | | | | |
| Asbestos contaminated building materials | [redacted] | | [redacted] | | | | | |
| Emergency (putrescible) | | [redacted] | | | [redacted] | | | [redacted] |
| Emergency (other general waste) | | [redacted] | | | [redacted] | | | [redacted] |
| Soils (ACM) etc | | | [redacted] | | | | | |
| Land farming | [redacted] | | | | | [redacted] | [redacted] | |
| Waste transfer facility | | | | [redacted] | | [redacted] | [redacted] | |

1. Boral has signalled interest – set up a cell if and when required ... use as emergency site until needed
2. Contractual agreement to be activated if Boral unavailable (bushfire / other) ... could be annual costs of availability?
3. Assumes dedicated cell south of asbestos cell post 2019 (medium to high construction cost – drainage, lining)
4. Fall back to (3)
5. Cell established (see (1) above)
6. Contractual agreement – availability cost?
7. Possible site (establishment costs?)
8. Possible site (ownership, lower establishment costs?)
9. Possible – very high establishment costs / EIS etc
10. As for (9)
11. Facility could also serve for emergency transfer scenarios
12. Temporary sites at MLRMC (flat tops on interim landfill cells)

FURTHER TEMPORAL ANALYSIS UNDERTAKEN BY GINNINDERRY JOINT VENTURE PRIOR TO THE OCTOBER 2016 STEEING COMMITTEE MEETING

## Appendix B Potential emergencies and response risk matrix

| **Risk** (adapted from Riggall and Associates 2015) | **Likelyhood*** | **Consequence**** | **Risk *** rating** | **Potential response** |
|---|---|---|---|---|
| Landfill full through unexpected volumes or miscalculation | 3 | 4 | High | Ensure adequate funding and construction to keep 6 months spare capacity in advance |
| Contractual dispute / operator becomes insolvent | 2 | 3 | Medium | Due diligence in selection and management of contractor<br>Enforce step in rights |
| Labour / skills shortage, industrial action | 3 | 3 | Medium | Contract management |
| Power outage impacting on office, weighbridge, leachate pumping | 3 | 2 | Medium | Back up generators.<br>Response capacity – response teams with adequate numbers of trained and operationally ready staff to commence alternative operations. |
| Diesel shortage for compactors, bulldozers, water pumps and transfer station trucks – waste accepted and stockpiles – | 2 | 2 | Medium | Reserve fuel through Government controlled fuel rationing. |
| Severe weather, wet weather, high winds, electrical activity during thunderstorms so that waste transport and unloading become unsafe | 4 | 3 | High | Manage movement and tip face operations accordingly and delay as required.<br>Response capacity – response teams, with adequate numbers of trained and operationally ready staff to commence alternative operations |
| Landfill fire – current land fill face becomes unusable | 3 | 4 | High | Depending on extent of the emergency:<br>• move to alternative tip face<br>• close current landfill site and stockpile in separate area within the Mugga Lane precinct until the fire is controlled.<br>• In an extensive and or long running incident trigger the cross border response (Woodlawn). |

| **Risk** (adapted from Riggall and Associates 2015) | **Likelyhood*** | **Consequence**** | **Risk *** rating** | **Potential response** |
|---|---|---|---|---|
| Disease, pandemic, virus outbreak – infectious waste treatment, may include mass animal culls and burial | 2 | 4 | High | As above |
| Fire from surrounding lands – | 3 | 4 | High | • Minimise risk through land management<br>• Coordination with emergency services to minimise disruption to services. |
| Pollution or contamination of site | 3 | 4 | High | Isolate, close transfer station, emergency services Hazmat unit – temporarily divert waste to alternative site. Appropriate transport and disposal of hazardous material |
| Landfill failure, liner tear, leachate drainage discharge to the environment, explosive methane quantities detected, prolonged odour problems. | 3 | 4 | High | Temporary stockpile, extended period trigger transfer interstate. |
| Main entrance closure | 3 | 4 | High | Alternative access installed from Mugga Lane. Upgrade of Mugga Lane entrance to improve safety and access. Provide funding for critical pavement improvements. |
| Police investigation | 3 | 2 | Medium | Manage alternative tipface area within Mugga landfill area. |

**Likelyhood***

| | |
|---|---|
| Rare | 1 |
| Unlikely | 2 |
| Possible | 3 |
| Likely | 4 |
| Almost certain | 5 |

**Consequence****

| | |
|---|---|
| Insignificant | 1 |
| Minor | 2 |
| Moderate | 3 |
| Major | 4 |
| Catastrophic | 5 |

**Risk Rating*** (Priority for attention)**

| | |
|---|---|
| Extreme | Director General |
| High | Senior Executive |
| Medium | Managers |
| Low | All staff |

## APPENDIX C - DRAFT ONLY Budget Items for closure WBRMC (not including alternative emergency landfill options)

| | | 2016 /17 | 2017 /18 | 2018 /19 | 2019 /20 | 2020 /21 | Total |
|---|---|---|---|---|---|---|---|
| | **Closure & Post Closure** (there is some duplication in these reports, which could probably be avoided with one or two larger Reports within costing to remain the same) preparation of reports: | | | | | | |
| 1.1 | Conceptual Site Model and Site Audit information | $30,000 | | | | | $30,000 |
| 1.3 | Closure and Capping/Rehabilitation Plan | $35,000 | $110,000 | | | | $145,000 |
| 1.4 | Aftercare Management Plan | | $30,000 | | | | $30,000 |
| 1.5 | Environmental Monitoring Plan | | $20,000 | | | | $20,000 |
| 1.6 | Landfill Gas Monitoring Plan/Remediation Plan | | $30,000 | | $10,000 | | $40,000 |
| 1.7 | Gas migration report (if found to be required) | | $50,000 | | | | $50,000 |
| 1.8 | Test pitting | | $50,000 | | | | $50,000 |
| | Sub total | | | | | | $365,000 |
| 2 | **Installation of Landfill gas bores as per BPEM** | | $200,000 | | | | $200,000 |
| | Sub total | | | | | | $200,000 |
| 4 | **Funding for the removal or relocation of WBRMC infrastructure** | | | | | | |
| 4.1 | Report on Assets to be Removed | | $20,000 | | | | $20,000 |
| 4.2 | Oil collection facility and provisional sum for contaminated soil | | | $120,000 | | | $120,000 |
| 4.3 | Oil storage tanks, fences and concrete slab | | | $60,000 | | | $60,000 |
| 4.4 | Weighbridge | | | | $50,000 | | $50,000 |
| 4.5 | Paper cage | | | $10,000 | | | $10,000 |
| 4.6 | Site office, forecourt office, old EPA office, internal motorised gates | | | | | $200,000 | $200,000 |
| 4.7 | BWR carport/ lean-too, maintenance shed | | | | $15,000 | | $15,000 |
| 4.8 | Irrigation pumps/infrastructure (sprinklers) | | | | $20,000 | | $20,000 |
| 4.10 | Forecourt hardstand removal | | | | | $300,000 | $300,000 |
| | Sub total | | | | | | $795,000 |
| 5 | **Works Associated with Closure** | | | | | | |
| 5.1 | CSG site capping @$90 p/m2 geomembrane (55,000m2) | | | | $4,950,000 | | $4,950,000 |
| 5.2 | BWR capping @ $71 p/m2 of which 50% complete with clay. (40,000m2) | | | $710,000 | $710,000 | | $1,420,000 |
| 5.3 | Asbestos Pit Capping @$71 p/m2 (17,000m2) + VENM @ 2m | | | | $1,547,000 | | $1,547,000 |
| 5.4 | Create natural drainage lines/remove artificial drainage | | | | $1,900,000 | | $1,900,000 |
| 5.5 | Seeding and establishment/erosion control | | $150,000 | $150,000 | $150,000 | $100,000 | $550,000 |
| 5.6 | Superintendence | | | $250,000 | $250,000 | | $500,000 |
| 5.7 | GITA | | | $250,000 | $250,000 | | $500,000 |
| 5.8 | Contaminated site auditor | | $25,000 | $50,000 | $50,000 | $100,000 | $225,000 |
| 5.9 | Removal of grey water dams (fill+shaping) | | | | $300,000 | $200,000 | $500,000 |
| 5.10 | Leachate management | | | | $300,000 | | $300,000 |
| 5.11 | Gas extraction modifications to allow public access | | | | $200,000 | | $200,000 |
| | Sub total | | | | | | $12,592,000 |
| | **Items not included** | | | | | | |
| 5 | **Clearance and Remediation of Parkwood Estate- currently unknown** | | | | | | $0 |
| 6 | **Gas migration mitigation measures (subterrain concretes walls etc)** | | | | | | $0 |
| 7 | **Excavation of waste (to achieve draft masterplan)** | | | | | | $0 |
| | Total (excluding contingency and management) | | | | | | $13,952,000 |
| | Contingency 10% (to be adjusted following contingency risk workshop) | | | | | | $2,790,400 |
| | Total Project budget excluding management | | | | | | $16,742,400 |
| | Insurance 1.5% | | | | | | $251,136 |
| | Capital Works oncost 5% | | | | | | $837,120 |
| | Procurement Capital Works 4% | | | | | | $669,696 |
| | **TOTALS** | | | | | | $18,500,352 |

8 **Recurrent funding for the long-term monitoring and maintenance work p.a. @ c50 years TBC**

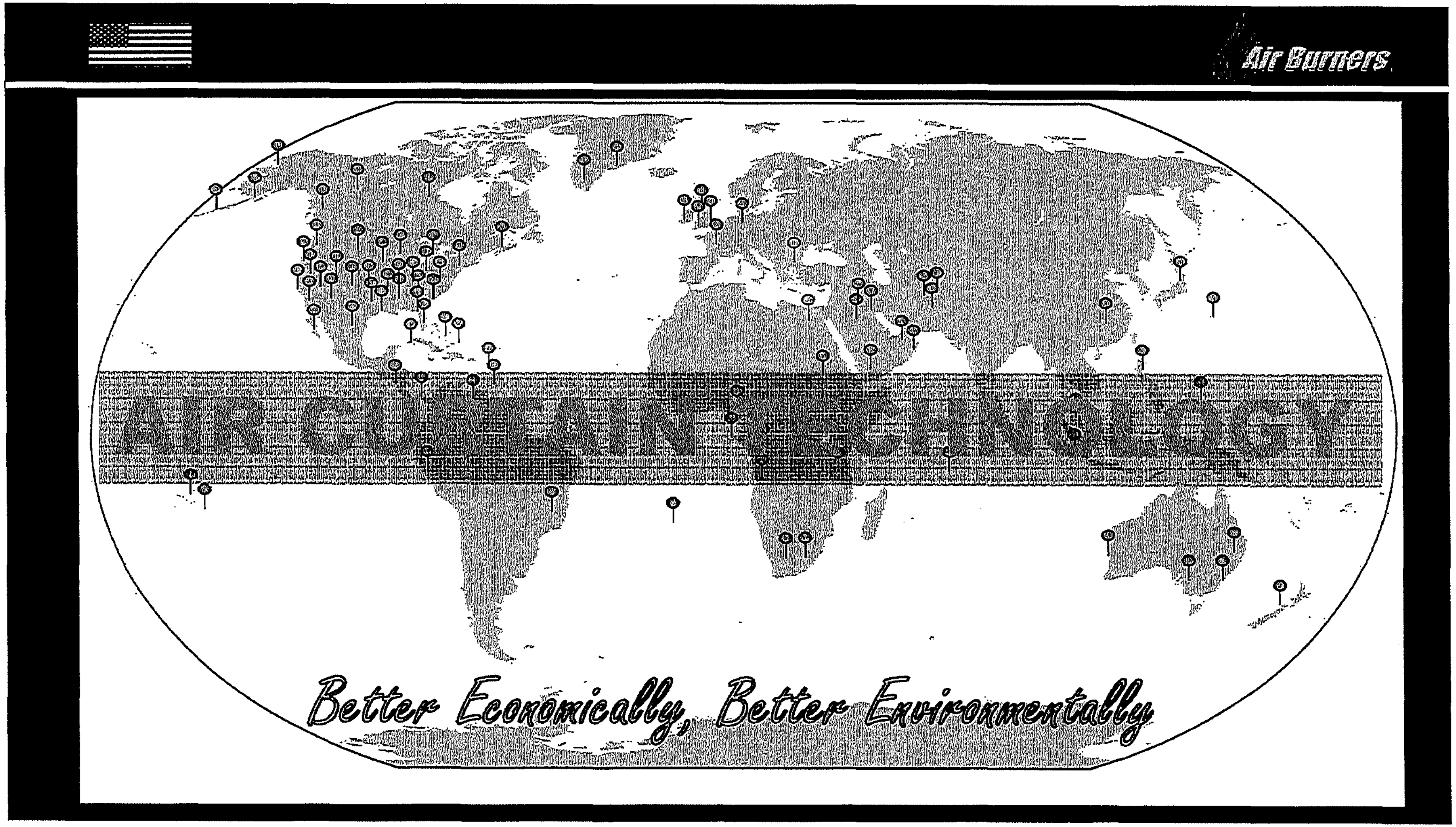
# Appendix D

**Initial list of organisations contacted by RT**

West Belconnen Steering committee (ACT Property, Treasury, EPSD, LDA, Ginninderry Joint Venture)
ACT NOWaste
ACT EPA
ACT Greenfield Planning
LDA Due Diligence
NSW EPA
NSW Planning
Goulburn Mullwarree Council
Queanbeyan Palerang Regional Council
Rail Planning
Access Recycling
Veolia
Hi Quality Windellema
Others for contact:
ACT Concrete recycling
Sita
Suez
Remondis

**References**

Business Continuity for Waste to Landfill Disposal Service. Riggall and Associates 2015
West Belconnen Joint Venture Agreement 2011
BPEM


Air Burners
Better Economically, Better Environmentally

*Air Curtain Burner*

Air Burners

# Purpose

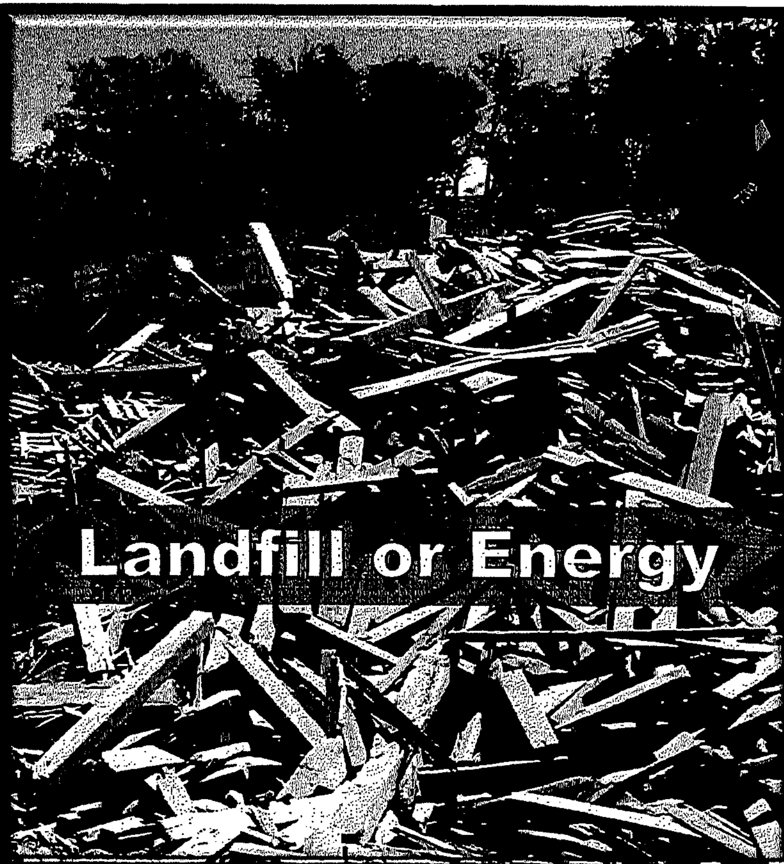
Review ACT Test Results

# Topics

- Background on Testing Program
- Review Testing Program
- Review Testing Results
- Better Biomass Management

# Testing Objective

Find a solution for elimination of mixed industrial wood waste which is currently going into landfill



# Testing Method

## Compare the results against the baseline

1) Clean wood waste as a baseline
2) Mixed industrial wood waste
3) Clean particle board and plywood
4) Laminated plywood

# Air Burners S119 Standard FireBox

- Standard Air Burners FireBox design
- Average maximum throughput 5 ton per hour

*Air Curtain Burner*

Air Burners

# Mike Lyons and Ektimo

Mike Lyons Project manager

Ektimo environmental testing

# Scope of Testing

## Airborne Emissions

Gases – CO, $CO_2$, NOx, $SO_2$, $O_2$

Particulate Emissions – Total solid particulates, metals and elements

Organic Combustion Products

Odour

## Ash Deposits

Analyze for residuals and heavy metals

*Air Curtain Burner* Air Burners

## Test No. 1 - Baseline Testing

Test clean wood waste as baseline for comparison

Includes logs and clean industrial wood waste with no coatings or treatment

# Test No. 2 – Mixed Industrial Wood

Mixed Industrial Wood Waste

Hand sorted on picking line

Building and demolition debris

Pallets, wood boxes etc.

Includes various paints and coatings

Includes some CCA treated boards

# Test No. 3 - Clean Particle Board and Plywood

Particle board and plywood
Manually sorted, picking line
Minor amounts of paint or spillage

## Test No. 4 - Laminated Plywood and Particle Board

- Glued products
- Plastic laminates as used in furniture
- Black laminates as used in concrete forming

# Testing Results

The following slides summarize the testing results

# Testing Amounts

S119 FireBox max capacity 5 tonnes per hour with clean wood waste

Lower rates are due density of waste material

More dense the waste material the slower the feed rate

| Test | Feed rate | Flow rate, dry | Flow rate, wet |
|---|---|---|---|
| | MT/hr | $Nm^3/min$ | $Nm^3/min$ |
| Clean wood waste | 4.2 | 240 | 252 |
| Mixed industrial wood waste | 3.8 | 246 | 252 |
| Clean particle board/plywood | 3.3 | 228 | 240 |
| Laminated waste | 3.75 | 330 | 336 |

## Air Curtain Burner

# PERMANENT GASES

Air Burners.

| Test | Permanent Gases | | |
|---|---|---|---|
| | CO | $NO_x$ | $SO_2$ |
| *Concentrations - $mg/Nm^3$* | | | |
| Clean wood waste | 610 | 40 | 33 |
| Mixed industrial wood waste | 77 | 54 | 12 |
| Clean particle board/plywood | 130 | 300 | 39 |
| Laminated waste | 440 | 200 | 4.7 |
| *Mass Rates - g/min* | | | |
| Clean wood waste | 146 | 9.6 | 7.9 |
| Mixed industrial wood waste | 18.9 | 13.3 | 3.0 |
| Clean particle board/plywood | 29.6 | 68.4 | 8.9 |
| Laminated waste | 145 | 66.0 | 1.6 |
| | | | |
| *Feedstock ratios - kg/MT* | | | |
| Clean wood waste | 2.091 | 0.137 | 0.113 |
| Mixed industrial wood waste | 0.299 | 0.210 | 0.047 |
| Clean particle board/plywood | 0.539 | 1.244 | 0.162 |
| Laminated waste | 2.323 | 1.056 | 0.025 |
| *Feedstock ratios - lbs/UST* | | | |
| Clean wood waste | 4.183 | 0.274 | 0.226 |
| Mixed industrial wood waste | 0.598 | 0.419 | 0.093 |
| Clean particle board/plywood | 1.078 | 2.487 | 0.323 |
| Laminated waste | 4.646 | 2.112 | 0.050 |

| Combustion Gases | | |
|---|---|---|
| % $CO_2$ | % $O_2$ | % $H_2O$ |
| *Concentrations - %* | | |
| 2.7 | 18.2 | 4.4 |
| 2.8 | 18.1 | 2.0 |
| 3.7 | 17.0 | 4.6 |
| 2.8 | 18.0 | 2.5 |

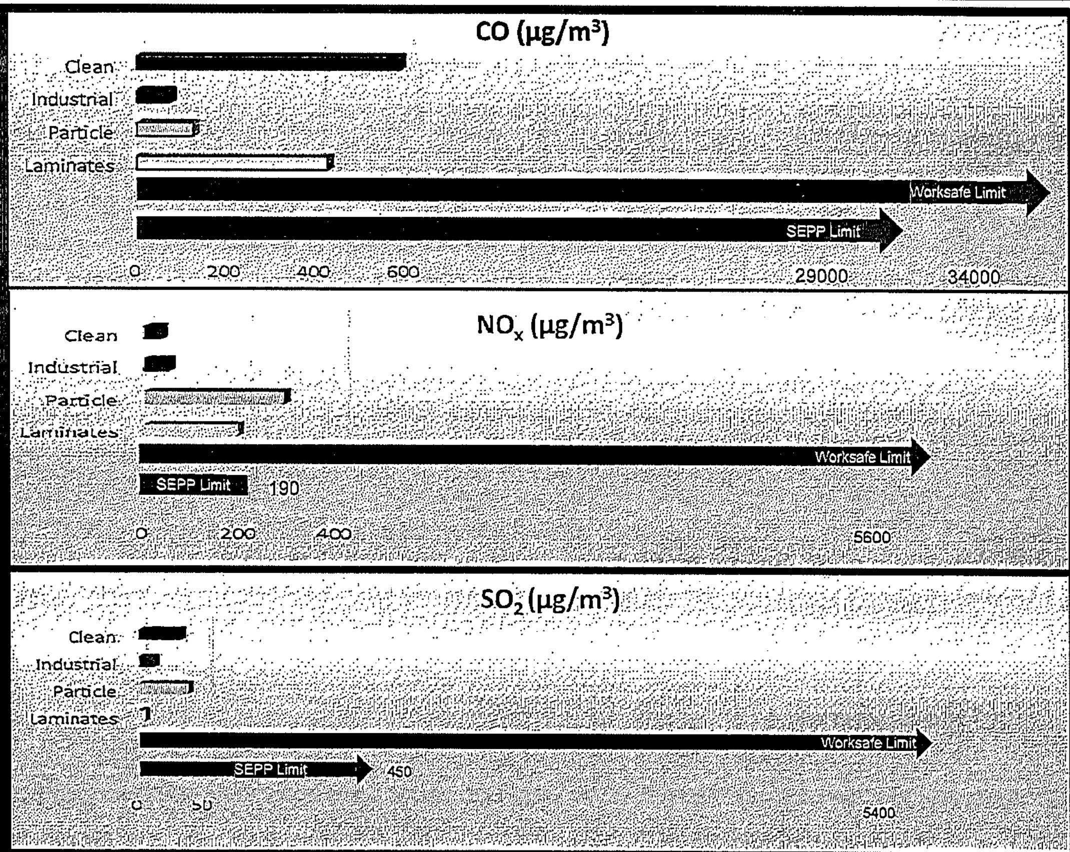



Table is actual sampling results

Charts are Modelling of maximum ground level concentration in the immediate vicinity

## Air Curtain Burner — PARTICULATE EMISSIONS

Air Burners.

| Test | Total Pcls |
|---|---|
| *Concentrations - mg/Nm³* | |
| Clean wood waste | 24.0 |
| Mixed industrial wood waste | 33.0 |
| Clean particle board/plywood | 47.0 |
| Laminated waste | 32.0 |
| *Mass Rates - g/min* | |
| Clean wood waste | 5.8 |
| Mixed industrial wood waste | 8.1 |
| Clean particle board/plywood | 10.7 |
| Laminated waste | 10.6 |
| | |
| *Feedstock ratios - kg/MT* | |
| Clean wood waste | 0.082 |
| Mixed industrial wood waste | 0.128 |
| Clean particle board/plywood | 0.195 |
| Laminated waste | 0.169 |
| *Feedstock ratios - lbs/UST* | |
| Clean wood waste | 0.165 |
| Mixed industrial wood waste | 0.256 |
| Clean particle board/plywood | 0.390 |
| Laminated waste | 0.338 |

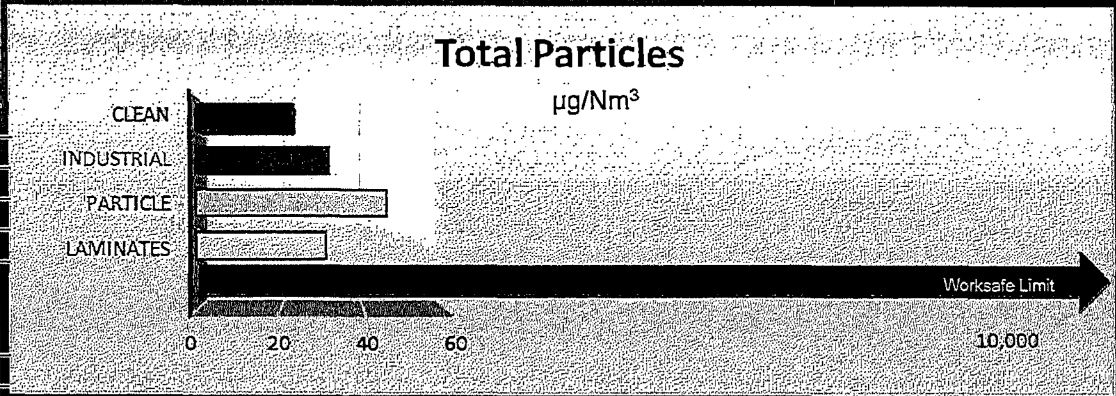
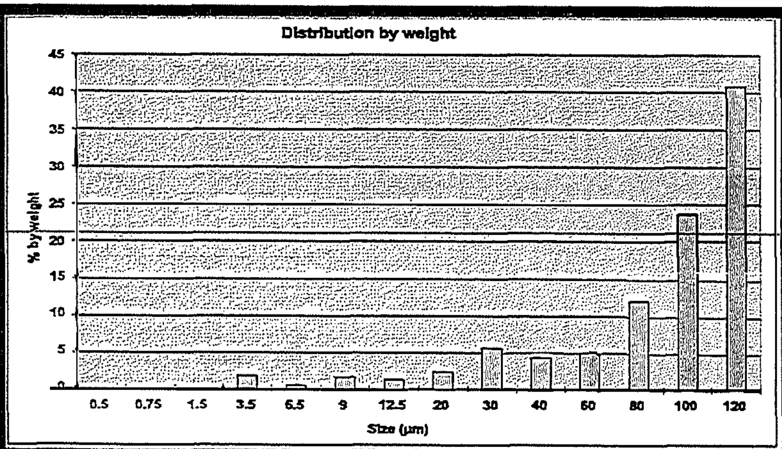



Table is actual sampling results

Charts are Modelling of maximum ground level concentration in the immediate vicinity

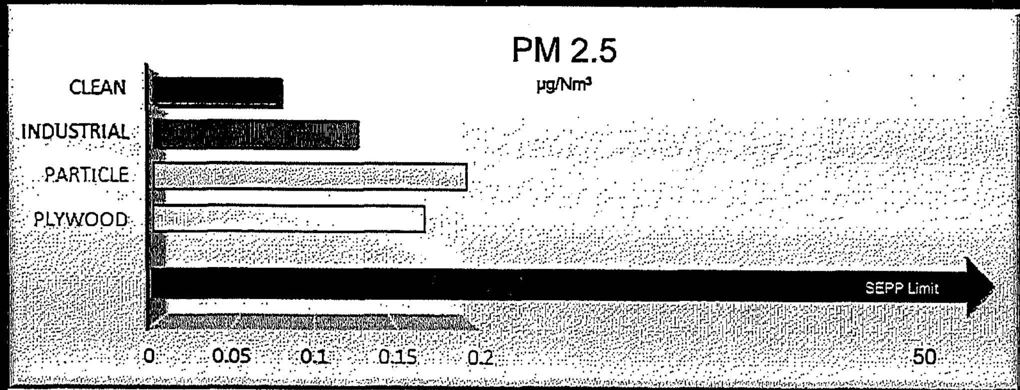
## *Air Curtain Burner* PARTICULATE EMISSIONS

Air Burners




Actual measured distribution by mass

Modelling maximum ground level concentration in the immediate vicinity. PM2.5 is 1.8% of TSP.



## CCA Contamination

### How does it happen?

While not done intentionally for this test, it is a good opportunity to look at the results of burning CCA contaminated wood. Weathered deck and fence timbers look almost identical to non-treated building timber.

### Can it be prevented?

Easily, with electronic sensors (see following section for further description)

### What were the results?

The Airborne arsenic particles are within the Worksafe requirements and for typical landfills would not pose a problem.
Chromium and Copper ash samples tested inside the limits but Arsenic test slightly outside the limits.
The residual ash samples for arsenic under the Prescribed Waste guidelines were 2200 mg/kg vs the 2000 mg/kg limit.

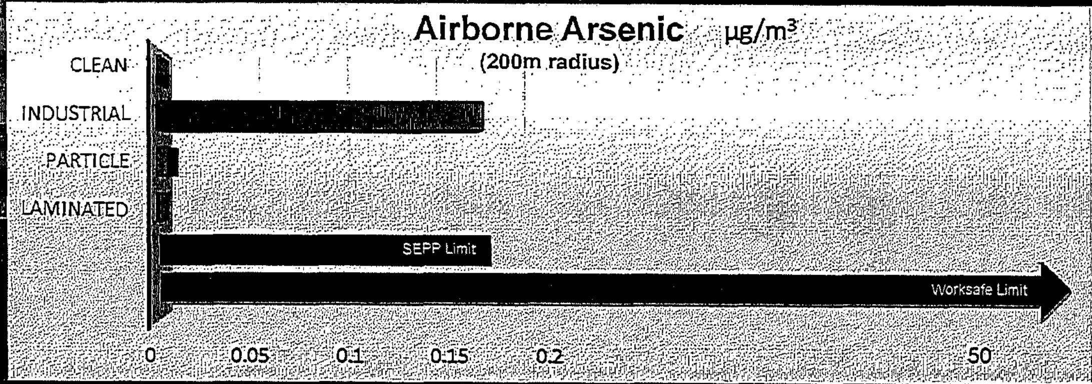
# Air Curtain Burner

# CCA EMISSIONS

Air Burners

| Element | Worksafe | SEPP | Test #1 | Test #2 | Test #3 | Test #4 |
|---|---|---|---|---|---|---|
| *Modelled GLC at 200m radius (µg/m³)* | | | | | | |
| Aluminium | 1000 | 33.3 | 0.0072 | 0.0313 | 0.0745 | 0.0360 |
| Antimony | 500 | 16.7 | 0.0011 | 0.0027 | 0.0006 | 0.0009 |
| Arsenic | 50 | 0.17 | 0.0010 | 0.1698 | 0.0062 | 0.0009 |
| Barium | 500 | 17 | 0.0016 | 0.0012 | 0.0017 | 0.0020 |
| Beryllium | 2 | 0.007 | 0.0002 | 0.0002 | 0.0002 | 0.0003 |
| Boron | 10000 | 333.3 | 0.0061 | 0.0056 | 0.0197 | 0.0114 |
| Cadmium | 10 | 0.033 | 0.0001 | 0.0002 | 0.0002 | 0.0007 |
| Calcium | 2000 | 66.7 | 0.1744 | 0.1452 | 0.3106 | 0.1648 |
| Chromium[VI] | 50 | 0.17 | 0.0006 | 0.0019 | 0.0006 | 0.0002 |
| Cobalt | 50 | 1.7 | 0.0002 | 0.0001 | 0.0001 | 0.0002 |
| Copper | 200 | 33 | 0.0020 | 0.0025 | 0.0009 | 0.0007 |
| Iron | 5000 | 166.7 | 0.0031 | 0.0219 | 0.0435 | 0.0213 |
| Lead | 150 | 5.0 | 0.0122 | 0.0380 | 0.0205 | 0.0390 |
| Lithium | 25 | 0.8 | 0.0002 | 0.0002 | 0.0001 | 0.0002 |
| Magnesium | 10000 | 333.3 | 0.1308 | 0.0894 | 0.0828 | 0.1199 |
| Manganese | 1000 | 33.3 | 0.0028 | 0.0029 | 0.0043 | 0.0042 |
| Mercury | 25 | 0.8 | 0.0002 | 0.0002 | 0.0001 | 0.0002 |
| Molybdenum | 5000 | 166.7 | 0.0002 | 0.0002 | 0.0002 | 0.0003 |
| Nickel | 100 | 3.3 | 0.0002 | 0.0002 | 0.0003 | 0.0003 |
| Phosphorus | 1000 | 33.3 | 0.0262 | 0.0076 | 0.0203 | 0.0108 |
| Potassium | 2000 | 66.7 | 0.9808 | 0.1966 | 0.3313 | 0.7492 |
| Selenium | 100 | 3.3 | 0.0011 | 0.0007 | 0.0006 | 0.0009 |
| Silver | 10 | 0.33 | 0.0002 | 0.0001 | 0.0001 | 0.0002 |
| Sodium | 2000 | 66.7 | 0.1962 | 0.1631 | 0.2278 | 0.9889 |
| Tin | 2000 | 66.7 | 0.0004 | 0.0013 | 0.0008 | 0.0009 |
| Vanadium | 50 | 1.7 | 0.0002 | 0.0002 | 0.0002 | 0.0003 |
| Zinc | 5000 | 170 | 0.0262 | 0.3351 | 0.1532 | 0.2397 |
| Titanium | 10000 | 333.3 | 0.0002 | 0.0010 | 0.0025 | 0.0023 |

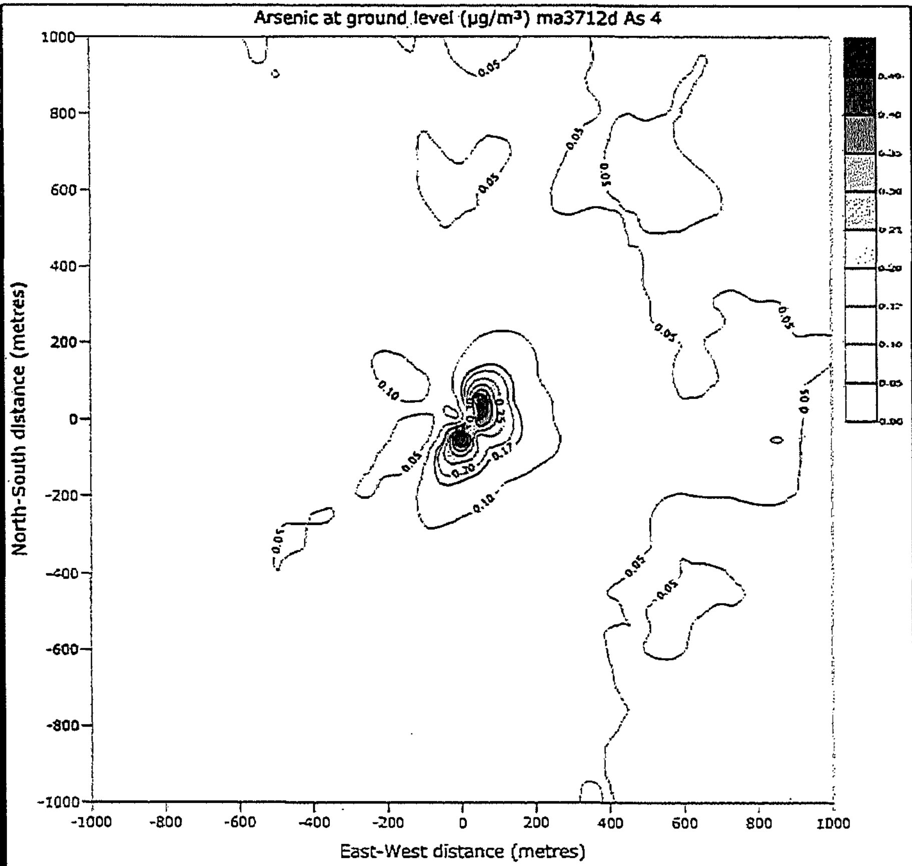
*Green cells are below WorkSafe and SEPP limits*




The only "Airborne Heavy Metal" to approach SEPP limits was arsenic due to CCA treated wood

Air Curtain Burner

# CCA EMISSIONS



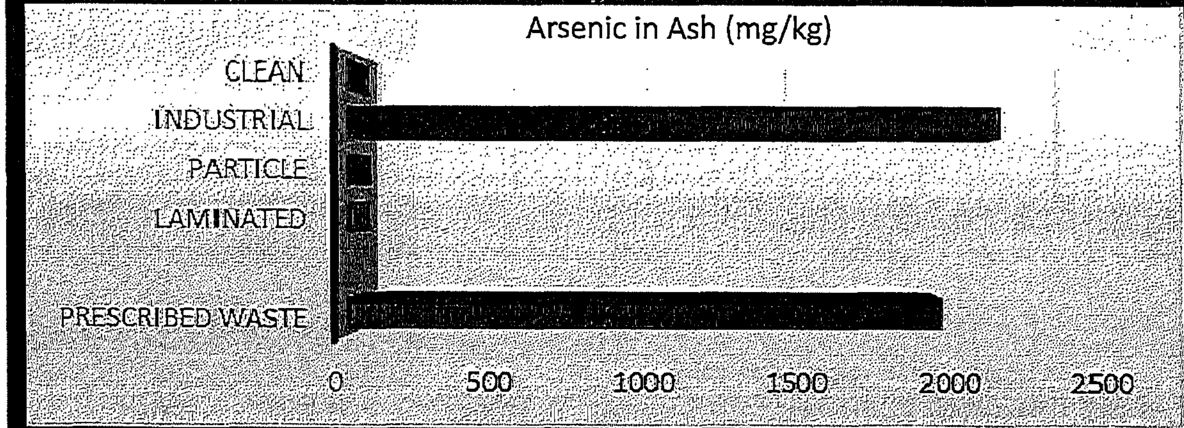
## Air Curtain Burner

# ASH ANALYSIS

Air Burners

| Test | Ash residual metals | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aluminium | Antimony | Arsenic | Barium | Beryllium | Boron | Cadmium | Calcium | Chromium | Cobalt | Copper | Iron | Lead | Lithium | Magnesium | Manganese | Mercury | Molybdenum | Nickel | Phosphorus | Potassium | Selenium | Silver | Sodium | Tin | Titanium | Vanadium | Zinc |
| *Concentrations – mg/kg* | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clean wood waste | 10000 | 7 | 4 | 94 | 1 | 16 | 0.4 | 9000 | 10 | 4 | 6 | 9300 | 9 | 1 | 2800 | 410 | 0.1 | 1 | 4 | 1600 | 3100 | 2 | 1 | 580 | 1 | 68 | 21 | 13 |
| Mixed industrial wood waste | 12000 | 7 | 2200 | 120 | 1 | 130 | 0.4 | 70000 | 1400 | 7 | 2100 | 7600 | 150 | 5 | 7200 | 740 | 0.1 | 1 | 7 | 2200 | 9800 | 2 | 1 | 13000 | 4 | 370 | 15 | 490 |
| Clean particle board/plywood | 13000 | 7 | 10 | 87 | 1 | 320 | 0.4 | 34000 | 13 | 3 | 17 | 7900 | 5 | 2 | 3500 | 420 | 0.1 | 1 | 5 | 1500 | 6900 | 2 | 1 | 7200 | 4 | 310 | 19 | 81 |
| Laminated waste | 8700 | 7 | 4 | 160 | 1 | 45 | 0.4 | 35000 | 10 | 7 | 7 | 6480 | 9 | 2 | 2100 | 280 | 0.1 | 1 | 4 | 590 | 5100 | 2 | 1 | 5600 | 1 | 420 | 16 | 130 |

*figures in red represent "less than limits of detection"*




The only "Residual Ash Heavy Metal" to approach Prescribed Waste guidelines resulted from the CCA treated wood

## CONTROLLING CCA



**At Sorting Line**

Inexpensive laser "mounted units" scan belt to insure no CCA

Scanners can be mounted at both beginning and end of sorting belt

Scanners will "log" all activity

**At the waste pile**

"Handheld" scanners are available

Waste can be checked by operator at any time

**At the ash pile**

Same handheld scanner will accurately indicate ash

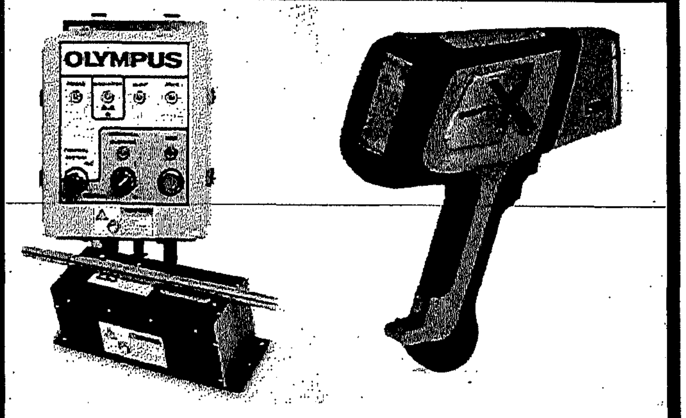
**For regulators**

Scanners could be required for license on Industrial waste

Regulators can use operators scanner during inspections

**Standard Ash Treatment**

Solidification and stabilization treatment for arsenic and all heavy metals using cement and lime.




Mounted unit example Handheld example

## Air Curtain Burner

# ORGANICS ANALYSIS

Air Burners

| Test | Organic components | | | |
|---|---|---|---|---|
| | Residuals as Toluene | Benzene | Toluene | Total vs n-hexane |
| *Concentrations - mg/Nm$^3$* | | | | |
| Clean wood waste | 0.65 | 12 | 0.48 | 14 |
| Mixed industrial wood waste | 0.37 | 0.3 | 0.32 | 0.49 |
| Clean particle board/plywood | 1.2 | 0.93 | 0.53 | 2.3 |
| Laminated waste | 0.70 | 1.1 | 0.65 | 1.6 |
| *Mass Rates - g/min* | | | | |
| Clean wood waste | 0.156 | 2.880 | 0.115 | 3.360 |
| Mixed industrial wood waste | 0.091 | 0.074 | 0.079 | 0.121 |
| Clean particle board/plywood | 0.274 | 0.212 | 0.121 | 0.524 |
| Laminated waste | 0.231 | 0.363 | 0.215 | 0.528 |

*figures in red represent "less than limits of detection"*

- Most readings are below the limits of detection
- Benzene and Toluene readings are both below SEPP and Worksafe limits

*Air Curtain Burner*

# ODOUR ANALYSIS

Air Burners

| Test | odour |
|---|---|
| *Concentrations - odour units (ou)* | |
| 1. Clean wood | 360 |
| 2. Painted wood | 770 |
| 3. Particle board | 1100 |
| 4. Laminates | - |
| *Emission rates - ouv/min* | |
| 1. Clean wood | 90,720 |
| 2. Painted wood | 194,040 |
| 3. Particle board | 264,000 |
| 4. Laminates | - |

Odour units have been applied to our "Air Dispersion Model" with the result that the worst case scenario (particle board, see chart at left) produced a maximum ground level concentration of 0.46ou.

This implies that no odour would be detectable beyond 50 meters from the FireBox.

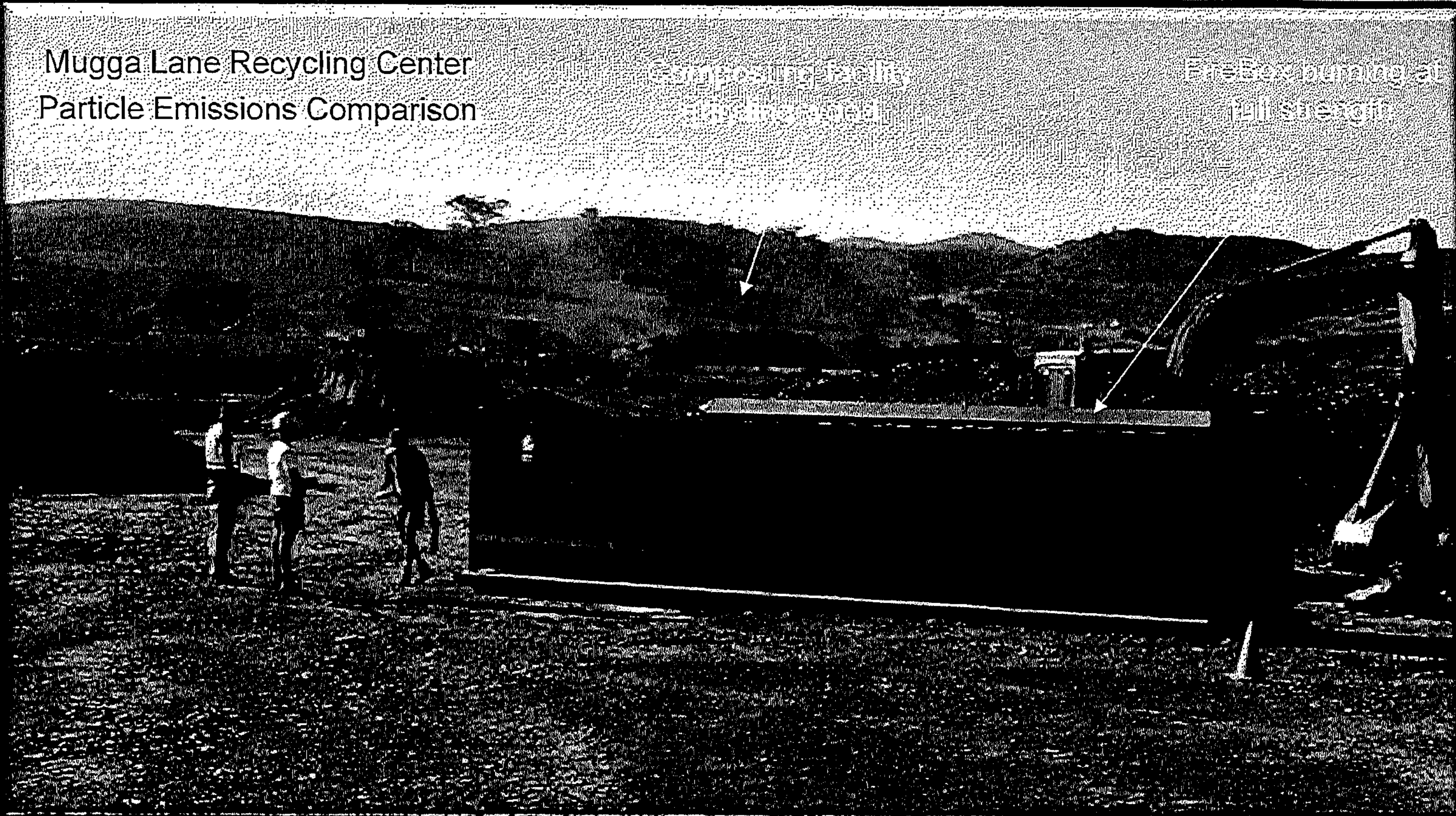
When compared to the Mugga Lane Compost site, the compost odour was objectionably noticeable at over 500 meters away.

## Why we recommend the use of the Air Curtain Burners over landfill

- Lower cost to municipalities
- Save valuable landfill capacity
- Lower emissions – versus grinding and hauling
- Energy recovery - reclassifies industrial wood waste as a "recyclable" product

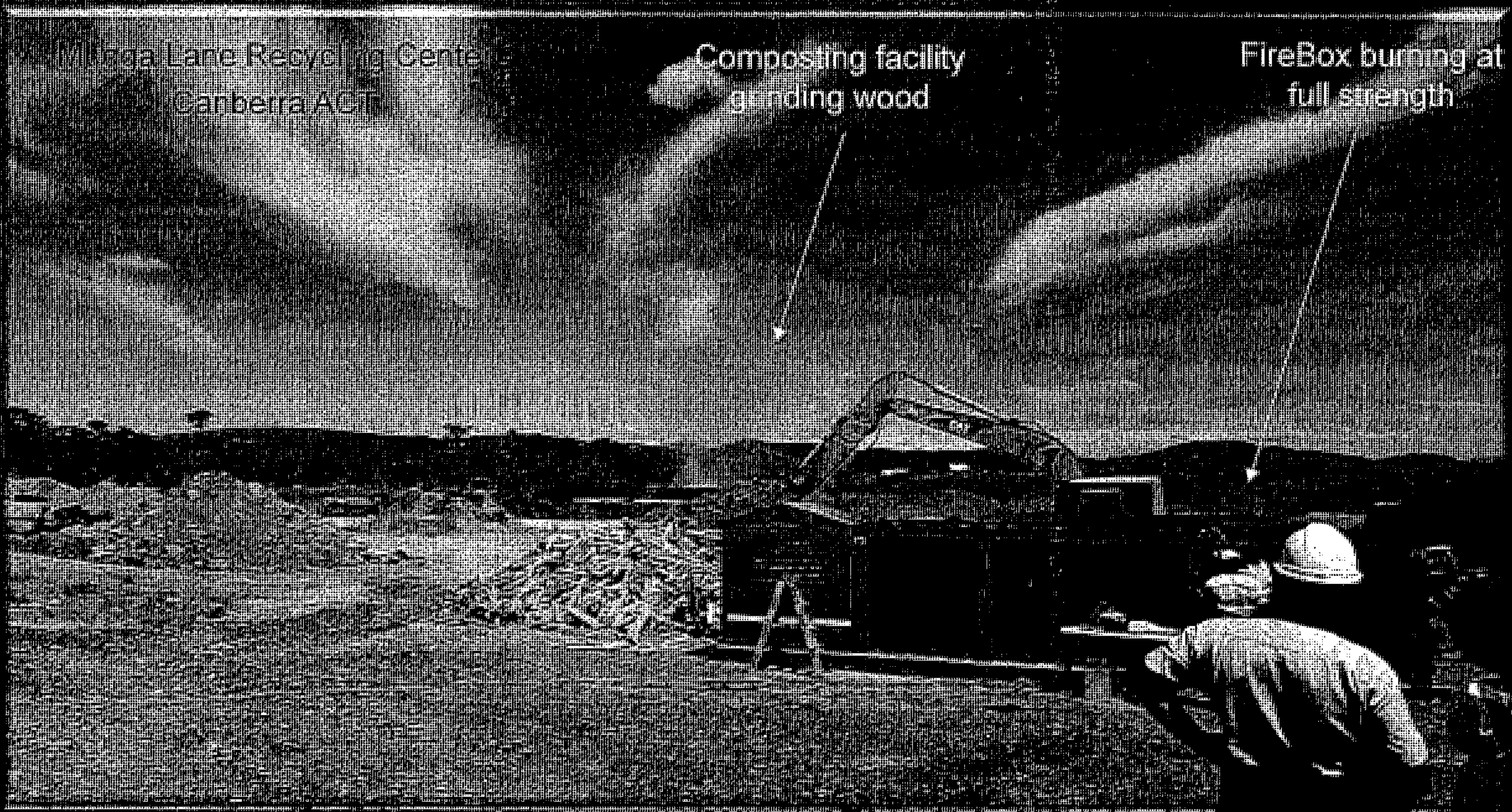
## *Air Curtain Burner*

*Air Burners*



# Air Curtain Burner

Air Burners

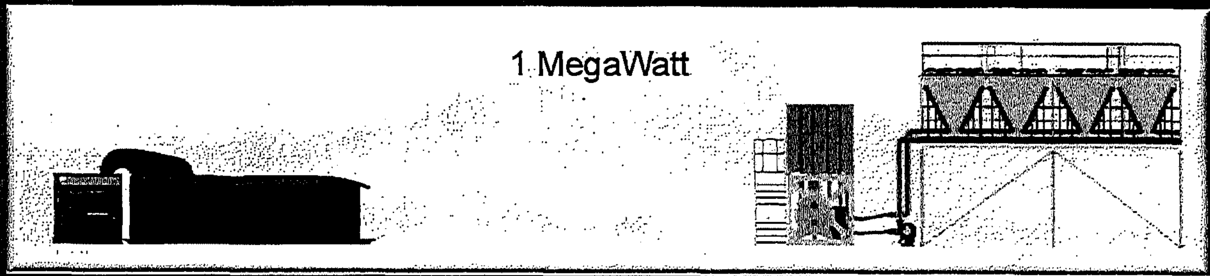


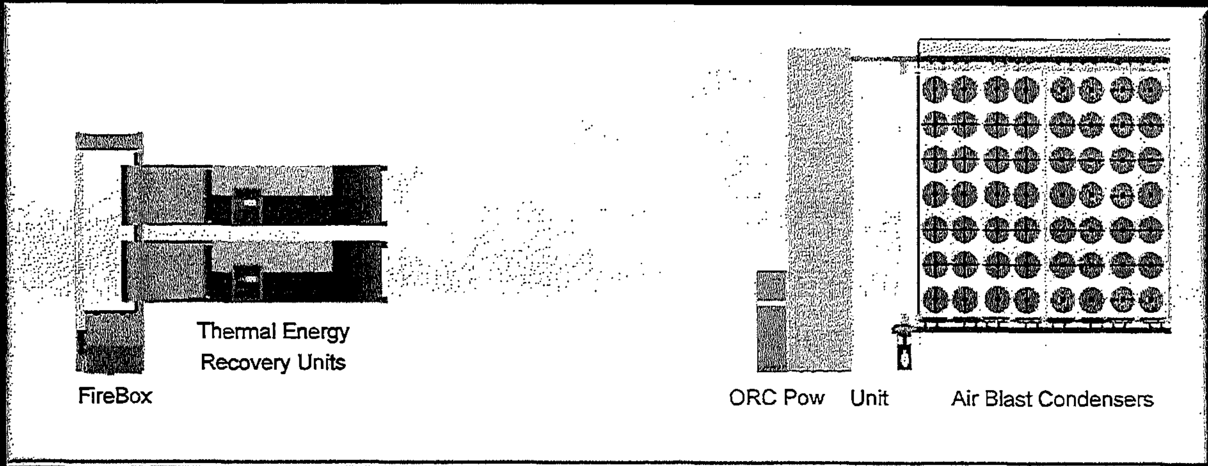
## *Air Curtain Burner*

Air Burners

Use the energy in the industrial wood waste to power the recycling equipment

PGFireBox



## Air Curtain Burner

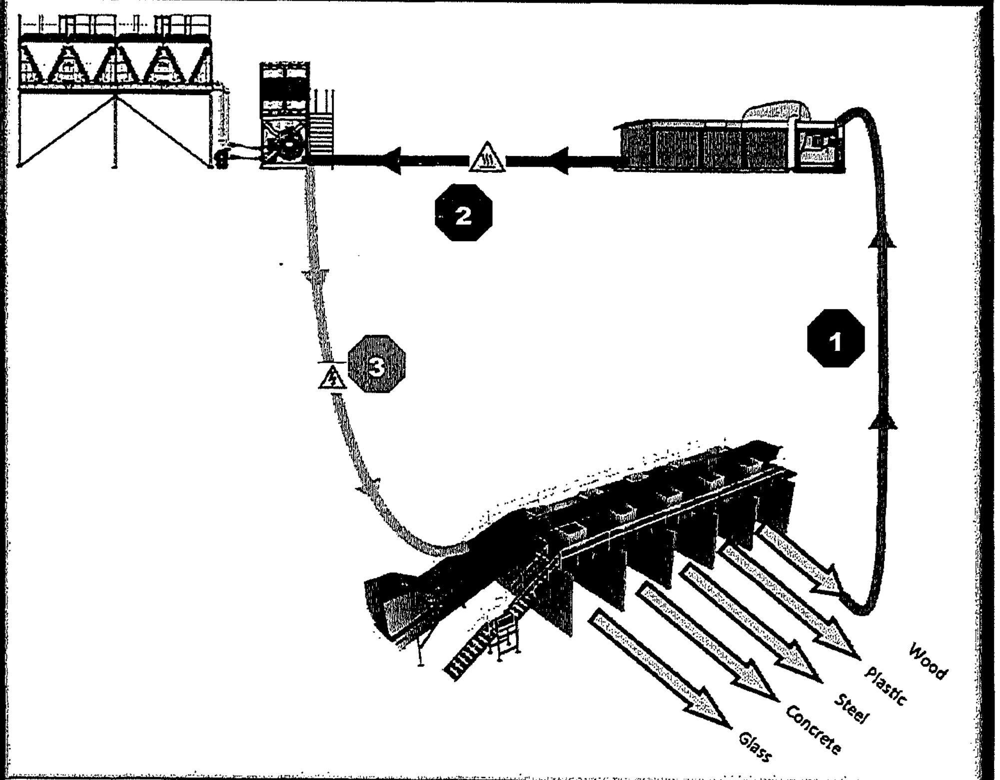
Air Burners

*Use the energy in the industrial wood waste to power the recycling equipment*

1 Conveyor belt delivers wood to FireBox

2 FireBox delivers heat to the ORC

3 ORC delivers electricity to the sorting station



Air Curtain Burner

Air Burners

# The End

Thank You

Ektimo

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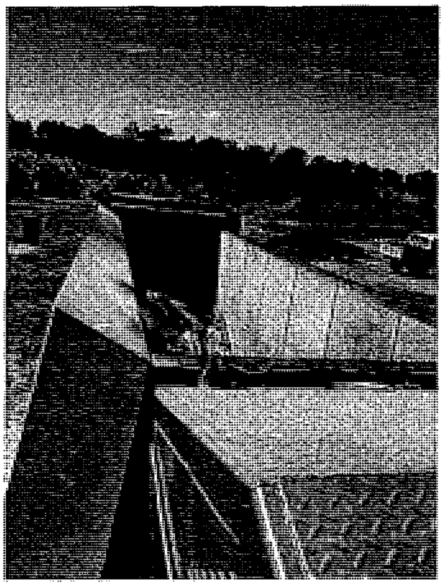
**Report Number R002410**

# Firebox Emission Testing Report
## ACT Waste Feasibility Study
## Territory and Municipal Services Directorate



## Document Information

| | |
|---|---|
| Client Name: | Territory and Municipal Services Directorate |
| Report Number: | R002410 |
| Date of Issue: | 2 May 2016 |
| Attention: | Chris Morrison |
| Address: | 12 Wattle st<br>Lyneham, ACT, 2602 |
| Testing Laboratory: | Ektimo (ETC) ABN 74 474 273 172 |

## Report Status

| Format | Document Number | Report Date | Prepared By | Reviewed By (1) | Reviewed By (2) |
|---|---|---|---|---|---|
| Preliminary Report | - | - | - | - | - |
| Draft Report | R002410[DRAFT] | 6/4/2016 | JWe/ADo | SCo | TBu |
| Draft Report 2 | R002410[DRAFT2] | 8/4/2016 | JWe/ADo | SCo | TBu |
| Draft Report 3 | R002410[DRAFT3] | 13/4/2016 | JWe/ADo | SCo | TBu |
| Final Report | R002410 | 2/5/2016 | JWe/ADo | SCo | TBu |
| Amend Report | - | - | - | - | - |

*Template Version: 160127*

## Amendment Record

| Document Number | Initiator | Report Date | Section | Reason |
|---|---|---|---|---|
| Nil | - | - | - | - |

## Report Authorisation

[redacted]

**Steven Cooper**
**Client Manager**

NATA

NATA Accredited Laboratory
No. 14601

[redacted]

**Terry Burkitt**
**Director (Quality)**

Accredited for compliance with ISO/IEC 17025. NATA is a signatory to the ILAC mutual recognition arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports

## Table of Contents

# 1 EXECUTIVE SUMMARY

Ektimo was engaged by the ACT Government, Territory and Municipal Services Directorate, to determine exhaust emissions and ash deposits from an Air Burners Inc. Model S119 Firebox located in Symonston, ACT.

Monitoring was performed as follows:

| Location | Test Date | Test Parameters* |
|---|---|---|
| Background | 17 February 2016 | Total particulate matter |
| | 18 February 2016 | Total particulate matter |
| Condition 1 – Clean Wood | 17 February 2016 | Total particulate matter, metals, nitrogen oxides, sulfur dioxide, carbon monoxide, oxygen, carbon dioxide, speciated volatile organic compounds (VOC's), smoke, odour |
| Condition 2 – Painted Wood | 17 February 2016 | Total particulate matter, metals, nitrogen oxides, sulfur dioxide, carbon monoxide, oxygen, carbon dioxide, speciated volatile organic compounds (VOC's),smoke, odour |
| Condition 3 – Plywood | 18 February 2016 | Total particulate matter, metals, nitrogen oxides, sulfur dioxide, carbon monoxide, oxygen, carbon dioxide, speciated volatile organic compounds (VOC's), smoke, odour |
| Condition 4 – Laminated Plywood | 18 February 2016 | Total particulate matter, metals, nitrogen oxides, sulfur dioxide, carbon monoxide, oxygen, carbon dioxide, speciated volatile organic compounds (VOC's), smoke |

* Flow rate, velocity, temperature and moisture were determined unless otherwise stated

All results are reported on a dry basis at STP (except odour wet – STP).

Background total particulate matter was taken upwind of the firebox on each day of sampling. This is representative of the air inevitably drawn upon to create the air curtain.

Flowrate and velocity was determined at 35 positions across the entire firebox during each burning condition. Due to the presence of the air curtain blowing across the top of the firebox areas of air ingress as well as egress were observed. Both conditions have been included in calculations to provide a net estimated flowrate. Pitot readings were taken approximately 150mm above the firebox to ensure all readings were taken above the air curtain.

Preliminary air flow investigations demonstrated that consistant egress flow was evident along the wall of the firebox opposite the air curtain manifold. All sampling was conducted from a single point approximately 300mm from this wall and between 1000-1500mm from the back of the firebox. This location yielded a positive flow in all traverses taken. Additionally as the firebox requires timber to be loaded into it frequently, sampling probes needed to be positioned to allow this to happen in a representative fashion.

The firebox was moved once burning was complete on 16 February 2016. It became apparent that the firebox was positioned on bitumen instead of dirt. This was not considered representative of a clean timber burn, with potential to bias all sampling results. Subsequently condition 1 sampling was repeated on 17 February 2016

Metals sampling was conducted through an inconel nozzle and probe. This deviates from the requirements of USEPA 29. Inconel was selected as it is durable enough to withstand incidental contact during sampling whilst maintaining structural integrity at high temperatures.

Residual ash samples were taken from the firebox at the conclusion of each sampling condition. The ash was analysed for the same suite of metals as the emission samples.

Combustion gases ($NO_x$, $SO_2$, $CO$, $CO_2$ & $O_2$) were logged every 10 seconds for the entire duration of each sampling condition. Graphs resultant from this testing have been appended to this report.

Smoke was compared to the Ringelmann chart during each condition. A Ringelmann number of 0 was recorded. Intermittant smoke was observed for short durations during loading, where the air curtain was momentarily obscured. During these short periods the smoke was still not considered thick enough to register any reading other than 0.

# 2 RESULTS

## 2.1 *Background Particulate Sampling – 17/02/16*

| | | | | | |
|---|---|---|---|---|---|
| **Date** | 17-02-2016 | **Client** | Territory and Municipal Services Directorate | | |
| **Report** | R002410 | **Stack ID** | Background | | |
| **Licence No.** | - | **Location** | Symonston | **State** | ACT |
| **Process Conditions** | Please refer to client records. | | | | |

| **Results** | Results |
|---|---|
| Sampling time | 1404-1450 |
| | Concentration mg/m³ |
| Total particulate matter | <1 |

## 2.2 *Background Particulate Sampling – 18/02/16*

| | | | | | |
|---|---|---|---|---|---|
| **Date** | 18-02-2016 | **Client** | Territory and Municipal Services Directorate | | |
| **Report** | R002410 | **Stack ID** | Background | | |
| **Licence No.** | - | **Location** | Symonston | **State** | ACT |
| **Process Conditions** | Please refer to client records. | | | | |

| **Results** | Results |
|---|---|
| Sampling time | 1540-1623 |
| | Concentration mg/m³ |
| Total particulate matter | <1 |

## 2.3 *Condition 1 - Clean Wood - 17/02/16*

| | | | | | |
|---|---|---|---|---|---|
| Date | 17-02-2016 | Client | Territory and Municipal Services Directorate | | |
| Report | R002410 | Stack ID | Firebox - Condition 1 - Clean Timber | | |
| Licence No. | - | Location | Symonston | State | ACT |
| Process Conditions | Please refer to client records. | | | | |

| **Sampling Plane Details** | | |
|---|---|---|
| Sampling plane dimensions | 1500 x 5700 mm | |
| Sampling plane area | 8.55 m² | |
| Sampling port size, number | 4" Flange (x7) | |
| Access & height of ports | Step ladder | 2.5 m |
| Duct orientation & shape | | Rectangular |
| Downstream disturbance | Exit | 0 D |
| Upstream disturbance | Junction | 0 D |
| No. traverses & points sampled | 7 | 35 |
| Compliance of sample plane to AS4323.1 | Non-compliant[(1)] | |

| **Stack Parameters** | | |
|---|---|---|
| Moisture content, %v/v | 4.4 | |
| Gas molecular weight, g/g mole | 28.8 (wet) | 29.3 (dry) |
| Gas density at STP, kg/m³ | 1.28 (wet) | 1.31 (dry) |
| | | |
| **Gas Flow Parameters** | | |
| Measurement time (hhmm) | 950 | |
| Temperature, °C | 375 | |
| Velocity at sampling plane, m/s | 1.3 | |
| Volumetric flow rate, discharge, m³/s | 11 | |
| Volumetric flow rate (wet STP), m³/s | 4.2 | |
| Volumetric flow rate (dry STP), m³/s | 4 | |
| Mass flow rate (wet basis), kg/hour | 19000 | |
| Sampling time, min | 108 | |

| **Gases** | Average | | Minimum | | Maximum | |
|---|---|---|---|---|---|---|
| Sampling time | 1036-1218 | | 1036-1218 | | 1036-1218 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Nitrogen oxides (as $NO_2$) | 40 | 9.5 | 23 | 5.5 | 78 | 19 |
| Sulfur dioxide | 33 | 7.9 | <3 | <0.7 | 350 | 84 |
| Carbon monoxide | 610 | 150 | 29 | 6.9 | 3300 | 790 |
| | Concentration % | | Concentration % | | Concentration % | |
| Carbon dioxide | 2.7 | | 1.5 | | 6 | |
| Oxygen | 18.2 | | 14.9 | | 19.4 | |

| **Smoke** | Results |
|---|---|
| Sampling time | 1036-1224 |
| Ringlemann number | 0 |

**(1) The sampling plane is deemed to be non-compliant due to the following reasons:**

The gas velocity at some or all sampling points is less than 3 m/s

The downstream disturbance is <1D from the sampling plane

The upstream disturbance is <2D from the sampling plane

| | | | |
|---|---|---|---|
| Date | 17-02-2016 | Client | Territory and Municipal Services Directorate |
| Report | R002410 | Stack ID | Firebox - Condition 1 - Clean Timber |
| Licence No. | - | Location | Symonston State ACT |
| Process Conditions | Please refer to client records. | | |

| Results | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| Sampling time | | | 1036-1224 | | 1036-1224 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Total particulate matter | 24 | 5.8 | 21 | 5.1 | 27 | 6.6 |
| Aluminium | 0.033 | 0.0078 | 0.027 | 0.0065 | 0.038 | 0.0092 |
| Antimony | <0.005 | <0.001 | <0.005 | <0.001 | <0.005 | <0.001 |
| Arsenic | 0.0046 | 0.0011 | 0.0045 | 0.0011 | 0.0048 | 0.0011 |
| Barium | 0.0074 | 0.0018 | 0.0063 | 0.0015 | 0.0085 | 0.002 |
| Beryllium | <0.001 | <0.0003 | <0.001 | <0.0003 | <0.001 | <0.0003 |
| Boron | 0.028 | 0.0067 | 0.027 | 0.0065 | 0.029 | 0.0069 |
| Cadmium | <0.0005 | <0.0001 | <0.0005 | <0.0001 | <0.0005 | <0.0001 |
| Calcium | <0.8 | <0.2 | <0.8 | <0.2 | <0.9 | <0.2 |
| Chromium | 0.0028 | 0.00067 | 0.0018 | 0.00043 | 0.0038 | 0.00092 |
| Cobalt | <0.0009 | <0.0002 | <0.0009 | <0.0002 | <0.001 | <0.0002 |
| Copper | 0.0094 | 0.0023 | 0.009 | 0.0022 | 0.0097 | 0.0023 |
| Iron | 0.014 | 0.0034 | 0.012 | 0.0028 | 0.016 | 0.0039 |
| Lead | 0.056 | 0.013 | 0.057 | 0.014 | 0.056 | 0.013 |
| Lithium | 0.00093 | 0.00022 | 0.0009 | 0.00022 | 0.00096 | 0.00023 |
| Magnesium | <0.6 | <0.1 | <0.5 | <0.1 | <0.6 | <0.1 |
| Manganese | 0.013 | 0.003 | 0.009 | 0.0021 | 0.016 | 0.0039 |
| Mercury | <0.001 | <0.0003 | <0.001 | <0.0003 | <0.001 | <0.0003 |
| Molybdenum | <0.001 | <0.0003 | <0.001 | <0.0003 | <0.001 | <0.0003 |
| Nickel | <0.001 | <0.0003 | <0.001 | <0.0003 | <0.001 | <0.0003 |
| Phosphorus | 0.12 | 0.028 | 0.11 | 0.026 | 0.12 | 0.03 |
| Potassium | 4.5 | 1.1 | 4.4 | 1.1 | 4.6 | 1.1 |
| Selenium | <0.005 | <0.001 | <0.005 | <0.001 | <0.005 | <0.001 |
| Silver | <0.0009 | <0.0002 | <0.0009 | <0.0002 | <0.001 | <0.0002 |
| Sodium | <0.9 | <0.2 | <0.8 | <0.2 | <0.9 | <0.2 |
| Tin | <0.002 | <0.0006 | <0.002 | <0.0005 | <0.002 | <0.0006 |
| Vanadium | <0.001 | <0.0003 | <0.001 | <0.0003 | <0.001 | <0.0003 |
| Zinc | 0.12 | 0.03 | 0.12 | 0.028 | 0.13 | 0.031 |
| Titanium | <0.001 | <0.0003 | <0.001 | <0.0003 | <0.001 | <0.0003 |

| Odour | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| | Concentration ou | Mass Rate oum³/s | Concentration ou | Mass Rate oum³/s | Concentration ou | Mass Rate oum³/s |
| Results | 360 | 1500 | 300 | 1300 | 420 | 1800 |
| Lower Uncertainty Limit | 250 | | 140 | | 190 | |
| Upper Uncertainty Limit | 530 | | 650 | | 920 | |
| Sampling date & Time | | | 17-02-16 | 1040 - 1052 | 17-02-16 | 1128 - 1136 |
| Analysis date & Time | | | 18-02-16 | 1400 | 18-02-16 | 1400 |
| Holding time | | | 27 hours | | 27 hours | |
| Dilution factor & Threshold | | | 1:15 | | 1:15 | |
| Butanol threshold | | | 52ppb | | 52ppb | |
| Laboratory temp | | | 23.2 ℃ | | 23.2 ℃ | |

| | | | | |
|---|---|---|---|---|
| **Date** | 17-02-2016 | **Client** | Territory and Municipal Services Directorate | |
| **Report** | R002410 | **Stack ID** | Firebox - Condition 1 - Clean Timber | |
| **Licence No.** | - | **Location** | Symonston | **State** ACT |
| **Process Conditions** | Please refer to client records. | | | |

| **Total VOCs*** (as n-Hexane) | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| Sampling time | | | 1036-1224 | | 1036-1224 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Total | 14 | 3.4 | 22 | 5.3 | 6.1 | 1.5 |

*Total VOCs does not include methane

| **VOC's (speciated)** | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| Sampling time | | | 1036-1224 | | 1036-1224 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Detection limit(2) | <0.5 | <0.1 | <0.4 | <0.09 | <0.6 | <0.1 |
| Benzene | 12 | 3 | 19 | 4.6 | 5.6 | 1.3 |
| Residuals as Toluene | ≤0.65 | ≤0.16 | 0.74 | 0.18 | <0.6 | <0.1 |

**(2) Unless otherwise reported, the following target compounds were found to be below detection:**
Ethanol, Isopropanol, Isobutanol, Butanol, 1-Methoxy-2-propanol, Cyclohexanol, 2-Butoxyethanol, Pentane, Hexane, Heptane, Octane, Nonane, Decane, Undecane, Dodecane, Tridecane, Tetradecane, Cyclohexane, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Isooctane, Methylcyclohexane, alpha-Pinene, beta-Pinene, d-Limonene, 3-Carene, Acetone, Methyl ethyl ketone, Ethyl acetate, Isopropyl acetate, Propyl acetate, MIBK, 2-Hexanone, Butyl acetate, 1-Methoxy-2-propyl acetate, Cyclohexanone, Cellosolve acetate, 2-Butoxyethyl acetate, Ethyldiglycol acetate, Diacetone alcohol, Isophorone, Benzene, Toluene, Ethylbenzene, m+p-Xylene, Styrene, o-Xylene, Isopropylbenzene, Propylbenzene, 1,3,5-Trimethylbenzene, alpha-Methylstyrene, tert-Butylbenzene, 1,2,4-Trimethylbenzene, 1,2,3-Trimethylbenzene, m-Diethylbenzene, o-Diethylbenzene, p-Diethylbenzene, Dichloromethane, Chloroform, 1,1,1-Trichloroethane, 1,2-Dichloroethane, Carbon tetrachlorida, 1,1-Dichloroethene, cis-1,2-Dichloroethene, trans-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, 1,1,2-Trichloroethane, 1,1,2,2-Tetrachloroethane, Chlorobenzene, Fluorobenzene

## 2.4 *Condition 2 - Painted Wood - 17/02/16*

| | | | | |
|---|---|---|---|---|
| Date | 17-02-2016 | Client | Territory and Municipal Services Directorate | |
| Report | R002410 | Stack ID | Firebox - Condition 2 - Painted Timber | |
| Licence No. | - | Location | Symonston | State ACT |
| Process Conditions | Please refer to client records. | | | |

| Sampling Plane Details | | |
|---|---|---|
| Sampling plane dimensions | 1500 x 5700 mm | |
| Sampling plane area | 8.55 m² | |
| Sampling port size, number | 4" Flange (x7) | |
| Access & height of ports | Step ladder | 2.5 m |
| Duct orientation & shape | | Rectangular |
| Downstream disturbance | Exit | 0 D |
| Upstream disturbance | Junction | 0 D |
| No. traverses & points sampled | 7 | 35 |
| Compliance of sample plane to AS4323.1 | Non-compliant(1) | |

| Stack Parameters | | |
|---|---|---|
| Moisture content, %v/v | 2 | |
| Gas molecular weight, g/g mole | 29.1 (wet) | 29.3 (dry) |
| Gas density at STP, kg/m³ | 1.30 (wet) | 1.31 (dry) |
| **Gas Flow Parameters** | | |
| Measurement time (hhmm) | 1445 | |
| Temperature, °C | 375 | |
| Velocity at sampling plane, m/s | 1.3 | |
| Volumetric flow rate, discharge, m³/s | 11 | |
| Volumetric flow rate (wet STP), m³/s | 4.2 | |
| Volumetric flow rate (dry STP), m³/s | 4.1 | |
| Mass flow rate (wet basis), kg/hour | 19000 | |
| Sampling time, min | 120 | |

| Gases | Average | | Minimum | | Maximum | |
|---|---|---|---|---|---|---|
| Sampling time | 1505-1649 | | 1505-1649 | | 1505-1649 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Nitrogen oxides (as $NO_2$) | 54 | 13 | 11 | 2.8 | 110 | 26 |
| Sulfur dioxide | 12 | 2.8 | 2.8 | 0.69 | 31 | 7.7 |
| Carbon monoxide | 77 | 19 | 12 | 3.1 | 470 | 110 |
| | Concentration % | | Concentration % | | Concentration % | |
| Carbon dioxide | 2.8 | | 1 | | 6.2 | |
| Oxygen | 18.1 | | 14.6 | | 20 | |

| Smoke | Results |
|---|---|
| Sampling time | 1456-1656 |
| Ringlemann number | 0 |

(1) The sampling plane is deemed to be non-compliant due to the following reasons:
The gas velocity at some or all sampling points is less than 3 m/s
The downstream disturbance is <1D from the sampling plane
The upstream disturbance is <2D from the sampling plane

| Date | 17-02-2016 | Client | Territory and Municipal Services Directorate | |
|---|---|---|---|---|
| Report | R002410 | Stack ID | Firebox - Condition 2 - Painted Timber | |
| Licence No. | - | Location | Symonston | State ACT |
| Process Conditions | Please refer to client records. | | | |

| Results | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| Sampling time | | | 1456-1656 | | 1456-1656 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Total particulate matter | 33 | 8.2 | 27 | 6.7 | 39 | 9.6 |
| Aluminium | 0.14 | 0.034 | 0.1 | 0.025 | 0.18 | 0.043 |
| Antimony | 0.012 | 0.0029 | 0.01 | 0.0025 | 0.013 | 0.0033 |
| Arsenic | 0.76 | 0.18 | 0.57 | 0.14 | 0.95 | 0.23 |
| Barium | 0.0052 | 0.0013 | 0.0039 | 0.00095 | 0.0065 | 0.0016 |
| Beryllium | <0.0009 | <0.0002 | <0.0008 | <0.0002 | <0.001 | <0.0002 |
| Boron | 0.025 | 0.006 | 0.015 | 0.0038 | 0.034 | 0.0082 |
| Cadmium | 0.00095 | 0.00023 | 0.00055 | 0.00014 | 0.0013 | 0.00033 |
| Calcium | 0.65 | 0.16 | 0.48 | 0.12 | 0.81 | 0.2 |
| Chromium | 0.0085 | 0.0021 | 0.0043 | 0.001 | 0.013 | 0.0031 |
| Cobalt | <0.0006 | <0.0001 | <0.0005 | <0.0001 | <0.0007 | <0.0002 |
| Copper | 0.011 | 0.0027 | 0.0075 | 0.0018 | 0.015 | 0.0036 |
| Iron | 0.098 | 0.024 | 0.082 | 0.02 | 0.11 | 0.028 |
| Lead | 0.17 | 0.042 | 0.11 | 0.028 | 0.23 | 0.056 |
| Lithium | <0.0007 | <0.0002 | <0.0006 | <0.0001 | <0.0009 | <0.0002 |
| Magnesium | <0.4 | <0.09 | <0.3 | <0.08 | <0.5 | <0.1 |
| Manganese | 0.013 | 0.0031 | 0.01 | 0.0025 | 0.015 | 0.0036 |
| Mercury | <0.0008 | <0.0002 | <0.0006 | <0.0002 | <0.0009 | <0.0002 |
| Molybdenum | <0.0009 | <0.0002 | <0.0008 | <0.0002 | <0.001 | <0.0002 |
| Nickel | <0.0009 | <0.0002 | <0.0008 | <0.0002 | <0.001 | <0.0002 |
| Phosphorus | 0.034 | 0.0083 | 0.027 | 0.0065 | 0.041 | 0.01 |
| Potassium | 0.88 | 0.22 | 0.62 | 0.15 | 1.1 | 0.28 |
| Selenium | <0.003 | <0.0008 | <0.003 | <0.0007 | <0.004 | <0.0009 |
| Silver | <0.0006 | <0.0001 | <0.0005 | <0.0001 | <0.0007 | <0.0002 |
| Sodium | 0.73 | 0.18 | 0.44 | 0.11 | 1 | 0.25 |
| Tin | 0.0059 | 0.0015 | 0.0051 | 0.0013 | 0.0067 | 0.0016 |
| Vanadium | <0.0009 | <0.0002 | <0.0008 | <0.0002 | <0.001 | <0.0002 |
| Zinc | 1.5 | 0.35 | 1.1 | 0.26 | 1.8 | 0.45 |
| Titanium | 0.0044 | 0.0011 | 0.0033 | 0.00082 | 0.0054 | 0.0013 |

| Odour | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| | Concentration ou | Mass Rate oum³/s | Concentration ou | Mass Rate oum³/s | Concentration ou | Mass Rate oum³/s |
| **Results** | **770** | **3200** | 800 | 3300 | 740 | 3100 |
| Lower Uncertainty Limit | 520 | | 370 | | 340 | |
| Upper Uncertainty Limit | 1100 | | 1700 | | 1600 | |
| Sampling date & Time | | | 17-02-16 | 1544 - 1601 | 17-02-16 | 1607 - 1622 |
| Analysis date & Time | | | 18-02-16 | 1400 | 18-02-16 | 1400 |
| Holding time | | | 22 hours | | 22 hours | |
| Dilution factor & Threshold | | | 12 | | 12 | |
| Butanol threshold | | | 52 ppb | | 52 ppb | |
| Laboratory temp | | | 23.2 ℃ | | 23.2 ℃ | |

| | | | |
|---|---|---|---|
| Date | 17-02-2016 | Client | Territory and Municipal Services Directorate |
| Report | R002410 | Stack ID | Firebox - Condition 2 - Painted Timber |
| Licence No. | - | Location | Symonston State ACT |
| Process Conditions | Please refer to client records. | | |

| Total VOCs* | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| (as n-Hexane) Sampling time | | | 1456-1656 | | 1456-1656 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Total | ≤0.49 | ≤0.12 | 0.38 | 0.094 | <0.6 | <0.1 |

*Total VOCs does not include methane

| VOC's (speciated) | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| Sampling time | | | 1456-1656 | | 1456-1656 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Detection limit(2) | <0.3 | <0.08 | <0.3 | <0.08 | <0.3 | <0.08 |
| Residuals as Toluene | ≤0.37 | ≤0.089 | 0.41 | 0.1 | <0.3 | <0.08 |

**(2) Unless otherwise reported, the following target compounds were found to be below detection:**
Ethanol, Isopropanol, Isobutanol, Butanol, 1-Methoxy-2-propanol, Cyclohexanol, 2-Butoxyethanol, Pentane, Hexane, Heptane, Octane, Nonane, Decane, Undecane, Dodecane, Tridecane, Tetradecane, Cyclohexane, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Isooctane, Methylcyclohexane, alpha-Pinene, beta-Pinene, d-Limonene, 3-Carene, Acetone, Methyl ethyl ketone, Ethyl acetate, Isopropyl acetate, Propyl acetate, MIBK, 2-Hexanone, Butyl acetate, 1-Methoxy-2-propyl acetate, Cyclohexanone, Cellosolve acetate, 2-Butoxyethyl acetate, Ethyldiglycol acetate, Diacetone alcohol, Isophorone, Benzene, Toluene, Ethylbenzene, m+p-Xylene, Styrene, o-Xylene, Isopropylbenzene, Propylbenzene, 1,3,5-Trimethylbenzene, alpha-Methylstyrene, tert-Butylbenzene, 1,2,4-Trimethylbenzene, 1,2,3-Trimethylbenzene, m-Diethylbenzene, o-Diethylbenzene, p-Diethylbenzene, Dichloromethane, Chloroform, 1,1,1-Trichloroethane, 1,2-Dichloroethane, Carbon tetrachloride, 1,1-Dichloroethene, cis-1,2-Dichloroethene, trans-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, 1,1,2-Trichloroethane, 1,1,2,2-Tetrachloroethane, Chlorobenzene, Fluorobenzene

## 2.5 *Condition 3 - Plywood - 18/02/16*

| | | | | |
|---|---|---|---|---|
| **Date** | 18-02-2016 | **Client** | Territory and Municipal Services Directorate | |
| **Report** | R002410 | **Stack ID** | Firebox - Condition 3 - Plywood | |
| **Licence No.** | - | **Location** | Symonston | **State** ACT |
| **Process Conditions** | Please refer to client records. | | | |

| **Sampling Plane Details** | | |
|---|---|---|
| Sampling plane dimensions | 1500 x 5700 mm | |
| Sampling plane area | 8.55 m² | |
| Sampling port size, number | 4" Flange (x7) | |
| Access & height of ports | Step ladder | 2.5 m |
| Duct orientation & shape | | Rectangular |
| Downstream disturbance | Exit | 0 D |
| Upstream disturbance | Junction | 0 D |
| No. traverses & points sampled | 7 | 35 |
| Compliance of sample plane to AS4323.1 | Non-compliant(1) | |

| **Stack Parameters** | | |
|---|---|---|
| Moisture content, %v/v | 4.6 | |
| Gas molecular weight, g/g mole | 28.9 (wet) | 29.4 (dry) |
| Gas density at STP, kg/m³ | 1.29 (wet) | 1.31 (dry) |
| **Gas Flow Parameters** | | |
| Measurement time (hhmm) | 950 | |
| Temperature, °C | 195 | |
| Velocity at sampling plane, m/s | 0.88 | |
| Volumetric flow rate, discharge, m³/s | 7.5 | |
| Volumetric flow rate (wet STP), m³/s | 4 | |
| Volumetric flow rate (dry STP), m³/s | 3.8 | |
| Mass flow rate (wet basis), kg/hour | 19000 | |
| Sampling time, min | 120 | |

| **Gases** | Average | | Minimum | | Maximum | |
|---|---|---|---|---|---|---|
| Sampling time | 1035-1224 | | 1035-1224 | | 1035-1224 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Nitrogen oxides (as $NO_2$) | 300 | 69 | 95 | 22 | 640 | 150 |
| Sulfur dioxide | 39 | 9 | <3 | <0.7 | 69 | 16 |
| Carbon monoxide | 130 | 30 | 22 | 5.2 | 960 | 220 |
| | Concentration % | | Concentration % | | Concentration % | |
| Carbon dioxide | 3.7 | | 2.1 | | 7 | |
| Oxygen | 17 | | 13.7 | | 18.7 | |

| **Smoke** | Results |
|---|---|
| Sampling time | 1032-1232 |
| Ringlemann number | 0 |

**(1) The sampling plane is deemed to be non-compliant due to the following reasons:**
The gas velocity at some or all sampling points is less than 3 m/s
The downstream disturbance is <1D from the sampling plane
The upstream disturbance is <2D from the sampling plane

| | | | | | |
|---|---|---|---|---|---|
| Date | 18-02-2016 | Client | Territory and Municipal Services Directorate | | |
| Report | R002410 | Stack ID | Firebox - Condition 3 - Plywood | | |
| Licence No. | - | Location | Symonston | State | ACT |
| Process Conditions | Please refer to client records. | | | | |

| Results | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| Sampling time | | | 1032-1232 | | 1032-1232 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Total particulate matter | 47 | 11 | 52 | 12 | 42 | 9.7 |
| Aluminium | 0.36 | 0.083 | 0.36 | 0.082 | 0.36 | 0.083 |
| Antimony | <0.003 | <0.0008 | <0.003 | <0.0007 | <0.003 | <0.0008 |
| Arsenic | 0.03 | 0.007 | 0.037 | 0.0086 | 0.024 | 0.0054 |
| Barium | 0.008 | 0.0018 | 0.0082 | 0.0019 | 0.0079 | 0.0018 |
| Beryllium | <0.0009 | <0.0002 | <0.0009 | <0.0002 | <0.0009 | <0.0002 |
| Boron | 0.095 | 0.022 | 0.093 | 0.021 | 0.097 | 0.022 |
| Cadmium | 0.00094 | 0.00022 | 0.0012 | 0.00028 | 0.00066 | 0.00015 |
| Calcium | 1.5 | 0.35 | 1.5 | 0.34 | 1.6 | 0.36 |
| Chromium | 0.003 | 0.00069 | 0.0018 | 0.0004 | 0.0043 | 0.00099 |
| Cobalt | <0.0006 | <0.0001 | <0.0006 | <0.0001 | <0.0006 | <0.0001 |
| Copper | 0.0043 | 0.00099 | 0.0044 | 0.001 | 0.0042 | 0.00097 |
| Iron | 0.21 | 0.048 | 0.22 | 0.05 | 0.2 | 0.047 |
| Lead | 0.099 | 0.023 | 0.12 | 0.028 | 0.075 | 0.017 |
| Lithium | ≤0.00062 | ≤0.00014 | 0.00058 | 0.00013 | <0.0007 | <0.0002 |
| Magnesium | <0.4 | <0.1 | <0.4 | <0.1 | <0.4 | <0.1 |
| Manganese | 0.021 | 0.0048 | 0.022 | 0.005 | 0.02 | 0.0046 |
| Mercury | <0.0007 | <0.0002 | <0.0007 | <0.0002 | <0.0007 | <0.0002 |
| Molybdenum | <0.0009 | <0.0002 | <0.0009 | <0.0002 | <0.0009 | <0.0002 |
| Nickel | 0.0015 | 0.00034 | 0.0015 | 0.00034 | 0.0015 | 0.00035 |
| Phosphorus | 0.098 | 0.022 | 0.12 | 0.028 | 0.072 | 0.017 |
| Potassium | 1.6 | 0.36 | 1.8 | 0.42 | 1.3 | 0.31 |
| Selenium | <0.003 | <0.0008 | <0.003 | <0.0007 | <0.003 | <0.0008 |
| Silver | <0.0006 | <0.0001 | <0.0006 | <0.0001 | <0.0006 | <0.0001 |
| Sodium | 1.1 | 0.26 | 1.7 | 0.39 | 0.6 | 0.14 |
| Tin | 0.0041 | 0.00095 | 0.0053 | 0.0012 | 0.003 | 0.00069 |
| Vanadium | <0.0009 | <0.0002 | <0.0009 | <0.0002 | <0.0009 | <0.0002 |
| Zinc | 0.74 | 0.17 | 0.94 | 0.22 | 0.54 | 0.12 |
| Titanium | 0.012 | 0.0027 | 0.011 | 0.0024 | 0.013 | 0.0029 |

| Odour | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| | Concentration ou | Mass Rate oum³/s | Concentration ou | Mass Rate oum³/s | Concentration ou | Mass Rate oum³/s |
| Results | 1100 | 4400 | 980 | 4000 | 1200 | 4900 |
| Lower Uncertainty Limit | 750 | | 450 | | 560 | |
| Upper Uncertainty Limit | 1600 | | 2100 | | 2700 | |
| Sampling date & Time | | | 18-02-16 | 1045 - 1059 | 18-02-16 | 1205 - 1220 |
| Analysis date & Time | | | 19-02-16 | 1330 | 19-02-16 | 1330 |
| Holding time | | | 27 hours | | 25 hours | |
| Dilution factor & Threshold | | | 12 | | 12 | |
| Butanol threshold | | | 39 ppb | | 39 ppb | |
| Laboratory temp | | | 21°C | | 21°C | |

| Date | 18-02-2016 | Client | Territory and Municipal Services Directorate | |
|---|---|---|---|---|
| Report | R002410 | Stack ID | Firebox - Condition 3 - Plywood | |
| Licence No. | - | Location | Symonston | State ACT |
| Process Conditions | Please refer to client records. | | | |

| **Total VOCs*** | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| (as n-Hexane) Sampling time | | | 1032-1232 | | 1032-1232 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Total | 2.3 | 0.52 | 1.4 | 0.32 | 3.2 | 0.73 |

*Total VOCs does not include methane

| **VOC's (speciated)** | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| Sampling time | | | 1032-1232 | | 1032-1232 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Detection limit(2) | <0.4 | <0.09 | <0.3 | <0.07 | <0.5 | <0.1 |
| Benzene | ≤0.93 | ≤0.21 | <0.3 | <0.07 | 1.5 | 0.36 |
| Toluene | ≤0.53 | ≤0.12 | 0.56 | 0.13 | <0.5 | <0.1 |
| Residuals as Toluene | 1.2 | 0.29 | 0.92 | 0.21 | 1.6 | 0.36 |

**(2) Unless otherwise reported, the following target compounds were found to be below detection:**
Ethanol, Isopropanol, Isobutanol, Butanol, 1-Methoxy-2-propanol, Cyclohexanol, 2-Butoxyethanol, Pentane, Hexane, Heptane, Octane, Nonene, Decane, Undecane, Dodecane, Tridecane, Tetradecane, Cyclohexane, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Isooctane, Methylcyclohexane, alpha-Pinene, beta-Pinene, d-Limonene, 3-Carene, Acetone, Methyl ethyl ketone, Ethyl acetate, Isopropyl acetate, Propyl acetate, MIBK, 2-Hexanone, Butyl acetate, 1-Methoxy-2-propyl acetate, Cyclohexanone, Cellosolve acetate, 2-Butoxyethyl acetate, Ethyldiglycol acetate, Diacetone alcohol, Isophorone, Benzene, Toluene, Ethylbenzene, m+p-Xylene, Styrene, o-Xylene, Isopropylbenzene, Propylbenzene, 1,3,5-Trimethylbenzene, alpha-Methylstyrene, tert-Butylbenzene, 1,2,4-Trimethylbenzene, 1,2,3-Trimethylbenzene, m-Diethylbenzene, o-Diethylbenzene, p-Diethylbenzene, Dichloromethane, Chloroform, 1,1,1-Trichloroethane, 1,2-Dichloroethane, Carbon tetrachloride, 1,1-Dichloroethene, cis-1,2-Dichloroethene, trans-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, 1,1,2-Trichloroethane, 1,1,2,2-Tetrachloroethane, Chlorobenzene, Fluorobenzene

## 2.6 *Condition 4 – Laminated Plywood - 18/02/16*

| | | | |
|---|---|---|---|
| Date | 18-02-2016 | Client | Territory and Municipal Services Directorate |
| Report | R002410 | Stack ID | Firebox - Condition 4 - Laminated Plywood |
| Licence No. | - | Location | Symonston State ACT |
| Process Conditions | Please refer to client records. | | |

| Sampling Plane Details | | |
|---|---|---|
| Sampling plane dimensions | 1500 x 5700 mm | |
| Sampling plane area | 8.55 m² | |
| Sampling port size, number | 4" Flange (x7) | |
| Access & height of ports | Step ladder | 2.5 m |
| Duct orientation & shape | | Rectangular |
| Downstream disturbance | Exit | 0 D |
| Upstream disturbance | Junction | 0 D |
| No. traverses & points sampled | 7 | 35 |
| Compliance of sample plane to AS4323.1 | Non-compliant(1) | |

| Stack Parameters | | |
|---|---|---|
| Moisture content, %v/v | 2.5 | |
| Gas molecular weight, g/g mole | 29.0 (wet) | 29.3 (dry) |
| Gas density at STP, kg/m³ | 1.29 (wet) | 1.31 (dry) |
| **Gas Flow Parameters** | | |
| Measurement time (hhmm) | 1552 | |
| Temperature, °C | 347 | |
| Velocity at sampling plane, m/s | 1.6 | |
| Volumetric flow rate, discharge, m³/s | 14 | |
| Volumetric flow rate (wet STP), m³/s | 5.6 | |
| Volumetric flow rate (dry STP), m³/s | 5.5 | |
| Mass flow rate (wet basis), kg/hour | 26000 | |
| Sampling time, min | 108 | |

| Gases | Average | | Minimum | | Maximum | |
|---|---|---|---|---|---|---|
| Sampling time | 1353-1532 | | 1353-1532 | | 1353-1532 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Nitrogen oxides (as $NO_2$) | 200 | 65 | 54 | 18 | 440 | 150 |
| Sulfur dioxide | 4.7 | 1.5 | <3 | <0.9 | 29 | 9.4 |
| Carbon monoxide | 440 | 140 | 85 | 28 | 2200 | 710 |
| | Concentration % | | Concentration % | | Concentration % | |
| Carbon dioxide | 2.8 | | 1 | | 5.8 | |
| Oxygen | 18 | | 14.6 | | 19.9 | |

| Smoke | Results |
|---|---|
| Sampling time | 1348-1530 |
| Ringlemann number | 0 |

(1) The sampling plane is deemed to be non-compliant due to the following reasons:
The gas velocity at some or all sampling points is less than 3 m/s
The downstream disturbance is <1D from the sampling plane
The upstream disturbance is <2D from the sampling plane

| Date | 18-02-2016 | Client | Territory and Municipal Services Directorate |
|---|---|---|---|
| Report | R002410 | Stack ID | Firebox - Condition 4 - Laminated Plywood |
| Licence No. | - | Location | Symonston State ACT |
| Process Conditions | Please refer to client records. | | |

| Results | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| Sampling time | | | 1348-1530 | | 1348-1530 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Total particulate matter | 32 | 11 | 29 | 9.4 | 36 | 12 |
| Aluminium | 0.12 | 0.039 | 0.1 | 0.033 | 0.14 | 0.045 |
| Antimony | <0.003 | <0.001 | <0.003 | <0.001 | <0.003 | <0.001 |
| Arsenic | 0.003 | 0.001 | 0.003 | 0.00098 | 0.0031 | 0.001 |
| Barium | 0.0067 | 0.0022 | 0.006 | 0.002 | 0.0075 | 0.0025 |
| Beryllium | <0.0009 | <0.0003 | <0.0009 | <0.0003 | <0.0009 | <0.0003 |
| Boron | 0.038 | 0.012 | 0.032 | 0.011 | 0.043 | 0.014 |
| Cadmium | 0.0022 | 0.00072 | 0.0021 | 0.00069 | 0.0023 | 0.00075 |
| Calcium | 0.55 | 0.18 | 0.48 | 0.16 | 0.62 | 0.2 |
| Chromium | ≤0.00067 | ≤0.00022 | <0.0007 | <0.0002 | 0.00062 | 0.0002 |
| Cobalt | <0.0006 | <0.0002 | <0.0006 | <0.0002 | <0.0006 | <0.0002 |
| Copper | 0.0024 | 0.00078 | 0.0023 | 0.00075 | 0.0025 | 0.00082 |
| Iron | 0.071 | 0.023 | 0.057 | 0.019 | 0.085 | 0.028 |
| Lead | 0.13 | 0.044 | 0.14 | 0.047 | 0.13 | 0.041 |
| Lithium | ≤0.0007 | ≤0.00023 | <0.0008 | <0.0003 | 0.00062 | 0.0002 |
| Magnesium | <0.4 | <0.1 | <0.4 | <0.1 | <0.4 | <0.1 |
| Manganese | 0.014 | 0.0046 | 0.011 | 0.0037 | 0.017 | 0.0055 |
| Mercury | <0.0007 | <0.0002 | <0.0007 | <0.0002 | <0.0007 | <0.0002 |
| Molybdenum | <0.0009 | <0.0003 | <0.0009 | <0.0003 | <0.0009 | <0.0003 |
| Nickel | <0.0009 | <0.0003 | <0.0009 | <0.0003 | <0.0009 | <0.0003 |
| Phosphorus | 0.036 | 0.012 | 0.032 | 0.011 | 0.04 | 0.013 |
| Potassium | 2.5 | 0.83 | 2.2 | 0.73 | 2.9 | 0.94 |
| Selenium | <0.003 | <0.001 | <0.003 | <0.001 | <0.003 | <0.001 |
| Silver | <0.0006 | <0.0002 | <0.0006 | <0.0002 | <0.0006 | <0.0002 |
| Sodium | 3.3 | 1.1 | 2.5 | 0.82 | 4.2 | 1.4 |
| Tin | 0.003 | 0.001 | 0.0023 | 0.00077 | 0.0037 | 0.0012 |
| Vanadium | <0.0009 | <0.0003 | <0.0009 | <0.0003 | <0.0009 | <0.0003 |
| Zinc | 0.8 | 0.26 | 0.6 | 0.2 | 0.99 | 0.33 |
| Titanium | 0.0078 | 0.0026 | 0.006 | 0.002 | 0.0096 | 0.0031 |

| Total VOCs* (as n-Hexane) | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| Sampling time | | | 1348-1530 | | 1348-1530 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Total | ≤1.6 | ≤0.52 | 1.5 | 0.5 | <2 | <0.5 |

*Total VOCs does not include methane

| VOC's (speciated) | Average | | Test 1 | | Test 2 | |
|---|---|---|---|---|---|---|
| Sampling time | | | 1348-1530 | | 1348-1530 | |
| | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min | Concentration mg/m³ | Mass Rate g/min |
| Detection limit(2) | <0.7 | <0.2 | <0.4 | <0.1 | <0.9 | <0.3 |
| Benzene | ≤1.1 | ≤0.37 | 1.4 | 0.45 | <0.9 | <0.3 |
| Residuals as Toluene | <0.7 | <0.2 | <0.4 | <0.1 | <0.9 | <0.3 |

**(2) Unless otherwise reported, the following target compounds were found to be below detection:**
Ethanol, Isopropanol, Isobutanol, Butanol, 1-Methoxy-2-propanol, Cyclohexanol, 2-Butoxyethanol, Pentane, Hexane, Heptane, Octane, Nonane, Decane, Undecene, Dodecane, Tridecane, Tetradecane, Cyclohexane, 2-Methylhexane, 2,3-Dimethylpentane, 3-Methylhexane, Isooctane, Methylcyclohexane, alpha-Pinene, beta-Pinene, d-Limonene, 3-Carene, Acetone, Methyl ethyl ketone, Ethyl acetate, Isopropyl acetate, Propyl acetate, MIBK, 2-Hexanone, Butyl acetate, 1-Methoxy-2-propyl acetate, Cyclohexanone, Cellosolve acetate, 2-Butoxyethyl acetate, Ethyldiglycol acetate, Diacetone alcohol, Isophorone, Benzene, Toluene, Ethylbenzene, m+p-Xylene, Styrene, o-Xylene, Isopropylbenzene, Propylbenzene, 1,3,5-Trimethylbenzene, alpha-Methylstyrene, tert-Butylbenzene, 1,2,4-Trimethylbenzene, 1,2,3-Trimethylbenzene, m-Diethylbenzene, o-Diethylbenzene, p-Diethylbenzene, Dichloromethane, Chloroform, 1,1,1-Trichloroethane, 1,2-Dichloroethane, Carbon tetrachloride, 1,1-Dichloroethene, cis-1,2-Dichloroethene, trans-1,2-Dichloroethene, Trichloroethene, Tetrachloroethene, 1,1,2-Trichloroethane, 1,1,2,2-Tetrachloroethane, Chlorobenzene, Fluorobenzene

## 2.7 Ash Sample Analysis

| Ash Analysis (mg/kg) | Condition 1 | | | | Condition 2 | | | | Condition 3 | | | | Condition 4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Test 1 | Test 2 | Test 3 | Average | Test 1 | Test 2 | Test 3 | Average | Test 1 | Test 2 | Test 3 | Average | Test 1 | Test 2 | Test 3 | Average |
| Aluminium | 7800 | 10000 | 13000 | 10000 | 8600 | 15000 | 12000 | 12000 | 16000 | 7900 | 14000 | 13000 | 5200 | 10000 | 11000 | 8700 |
| Antimony | <7 | <7 | <7 | < 7 | <7 | <7 | <7 | < 7 | <7 | <7 | <7 | < 7 | <7 | <7 | <7 | < 7 |
| Arsenic | <4 | 4 | 4 | ≤ 4 | 2800 | 1900 | 1900 | 2200 | 14 | 6 | 9 | 10 | <4 | <4 | 4 | ≤ 4 |
| Barium | 87 | 110 | 84 | 94 | 170 | 78 | 110 | 120 | 46 | 66 | 150 | 87 | 180 | 72 | 240 | 160 |
| Beryllium | <1 | <1 | <1 | < 1 | <1 | <1 | <1 | < 1 | <1 | <1 | <1 | < 1 | <1 | <1 | <1 | < 1 |
| Boron | 20 | 20 | 9 | 16 | 110 | 170 | 110 | 130 | 120 | 140 | 99 | 120 | 30 | 68 | 37 | 45 |
| Cadmium | <0.4 | <0.4 | <0.4 | < 0.4 | <0.4 | <0.4 | <0.4 | < 0.4 | <0.4 | <0.4 | <0.4 | < 0.4 | <0.4 | <0.4 | <0.4 | < 0.4 |
| Calcium | 8700 | 13000 | 5400 | 9000 | 47000 | 97000 | 66000 | 70000 | 45000 | 24000 | 33000 | 34000 | 28000 | 29000 | 47000 | 35000 |
| Chromium | 7 | 10 | 13 | 10 | 1800 | 1000 | 1400 | 1400 | 16 | 7 | 15 | 13 | 7 | 11 | 13 | 10 |
| Cobalt | 3 | 4 | 4 | 4 | 6 | 8 | 7 | 7 | 4 | 2 | 4 | 3 | 9 | 6 | 6 | 7 |
| Copper | 6 | 6 | 5 | 6 | 2400 | 2100 | 1800 | 2100 | 26 | 6 | 20 | 17 | 4 | 9 | 7 | 7 |
| Iron | 6600 | 9400 | 12000 | 9300 | 5600 | 9700 | 7500 | 7600 | 10000 | 3700 | 10000 | 7900 | 4600 | 6900 | 7600 | 6400 |
| Lead | 5 | 9 | 12 | 9 | 98 | 250 | 110 | 150 | 9 | 1 | 5 | 5 | 7 | 12 | 7 | 9 |
| Lithium | <1 | <1 | 2 | ≤ 1 | 3 | 4 | 8 | 5 | 2 | <1 | 2 | ≤ 2 | 1 | 2 | 2 | 2 |
| Magnesium | 3400 | 2800 | 2100 | 2800 | 5300 | 9600 | 6700 | 7200 | 4200 | 2500 | 3800 | 3500 | 1500 | 2400 | 2400 | 2100 |
| Manganese | 360 | 470 | 390 | 410 | 610 | 820 | 790 | 740 | 510 | 280 | 470 | 420 | 200 | 280 | 360 | 280 |
| Mercury | <0.1 | <0.1 | <0.1 | < 0 | <0.1 | <0.1 | <0.1 | < 0.1 | <0.1 | <0.1 | <0.1 | < 0.1 | <0.1 | <0.1 | <0.1 | < 0.1 |
| Molybdenum | <1 | <1 | <1 | < 1 | <1 | 2 | 1 | ≤ 1 | <1 | <1 | <1 | < 1 | <1 | <1 | <1 | < 1 |
| Nickel | 4 | 4 | 4 | 4 | 5 | 8 | 8 | 7 | 7 | 3 | 6 | 5 | 3 | 4 | 4 | 4 |
| Phosphorus | 2100 | 1600 | 1000 | 1600 | 850 | 4300 | 1400 | 2200 | 1600 | 980 | 1900 | 1500 | 420 | 680 | 640 | 580 |
| Potassium | 3100 | 3600 | 2700 | 3100 | 7500 | 12000 | 10000 | 9800 | 9500 | 5400 | 5900 | 6900 | 5900 | 5000 | 4500 | 5100 |
| Selenium | <2 | <2 | <2 | < 2 | <2 | <2 | <2 | < 2 | <2 | <2 | <2 | < 2 | <2 | <2 | <2 | < 2 |
| Silver | <1 | <1 | <1 | < 1 | <1 | <1 | <1 | < 1 | <1 | <1 | <1 | < 1 | <1 | <1 | <1 | < 1 |
| Sodium | 600 | 630 | <500 | ≤ 580 | 17000 | 5800 | 17000 | 13000 | 14000 | 3300 | 4300 | 7200 | 5200 | 6300 | 5300 | 5600 |
| Tin | <1 | 1 | <1 | ≤ 1 | 3 | 4 | 4 | 4 | 9 | <1 | 2 | ≤ 4 | 1 | 2 | <1 | ≤ 1 |
| Titanium | 67 | 75 | 63 | 68 | 330 | 320 | 460 | 370 | 480 | 180 | 270 | 310 | 450 | 420 | 380 | 420 |
| Vanadium | 15 | 21 | 26 | 21 | 11 | 19 | 16 | 15 | 22 | 9 | 25 | 19 | 8 | 16 | 23 | 16 |
| Zinc | 10 | 13 | 15 | 13 | 320 | 580 | 580 | 490 | 130 | 38 | 76 | 81 | 150 | 120 | 130 | 130 |

## 3 TEST METHODS

All sampling and analysis was performed by Ektimo unless otherwise specified. Specific details of the methods are available upon request

| Parameter | Sampling Method | Analysis Method | Method Detection Limit | NATA Accredited Sampling | NATA Accredited Analysis |
|---|---|---|---|---|---|
| Sample plane criteria | AS 4323.1 | NA | - | ✓ | NA |
| Molecular weight | USEPA 3A | USEPA 3A | - | ✓ | ✓ |
| Moisture | USEPA 4 | USEPA 4 | 0.4% | ✓ | ✓ |
| Velocity | USEPA 2 | NA | $2ms^{-1}$ | ✓ | NA |
| Total particulate matter | AS 4323.2 | AS4323.2 | $1mg/m^3$ | ✓ | ✓ |
| Total (gaseous and particulate) Metals | USEPA 29 | Envirolab inhouse | Analyte specific | ✓ | ✓[1] |
| Nitrogen oxides | USEPA 7E | USEPA 7E | $4mg/m^3$ | ✓ | ✓ |
| Carbon monoxide | USEPA 10 | USEPA 10 | $2.5mg/m^3$ | ✓ | ✓ |
| Carbon dioxide | USEPA 3A | USEPA 3A | 0.1% | ✓ | ✓ |
| Oxygen | USEPA 3A | USEPA 3A | 0.1% | ✓ | ✓ |
| Sulfur dioxide | USEPA 6C | USEPA 6C | $6mg/m^3$ | ✓ | ✓ |
| Speciated volatile organic compounds | USEPA 18 | USEPA SW-846 8260 | $0.33mg/m^3$ | ✓ | ✓ |
| Odour | AS 4323.3 | AS 4323.3 | 30ou | ✓ | ✓ |

1 Analysis performed by Envirolab, NATA accreditation number 2901. Results were reported to Ektimo on 9/3/16 in report number 142518.

## 4 QUALITY ASSURANCE/ QUALITY CONTROL INFORMATION

Ektimo (EML) and Ektimo (ETC) are accredited by the National Association of Testing Authorities (NATA) for the sampling and analysis of air pollutants from industrial sources. Unless otherwise stated test methods used are accredited with the National Association of Testing Authorities. For full details, search for Ektimo at NATA's website www.nata.com.au.

Ektimo (EML) and Ektimo (ETC) are accredited by NATA (National Association of Testing Authorities) to ISO/IEC 17025. – General Requirements for the Competence of Testing and Calibration Laboratories. ISO/IEC 17025 requires that a laboratory have adequate equipment to perform the testing, as well as laboratory personnel with the competence to perform the testing. This quality assurance system is administered and maintained by the Compliance Manager.

NATA is a member of APLAC (Asia Pacific Laboratory Accreditation Co-operation) and of ILAC (International Laboratory Accreditation Co-operation). Through the mutual recognition arrangements with both of these organisations, NATA accreditation is recognised world –wide.

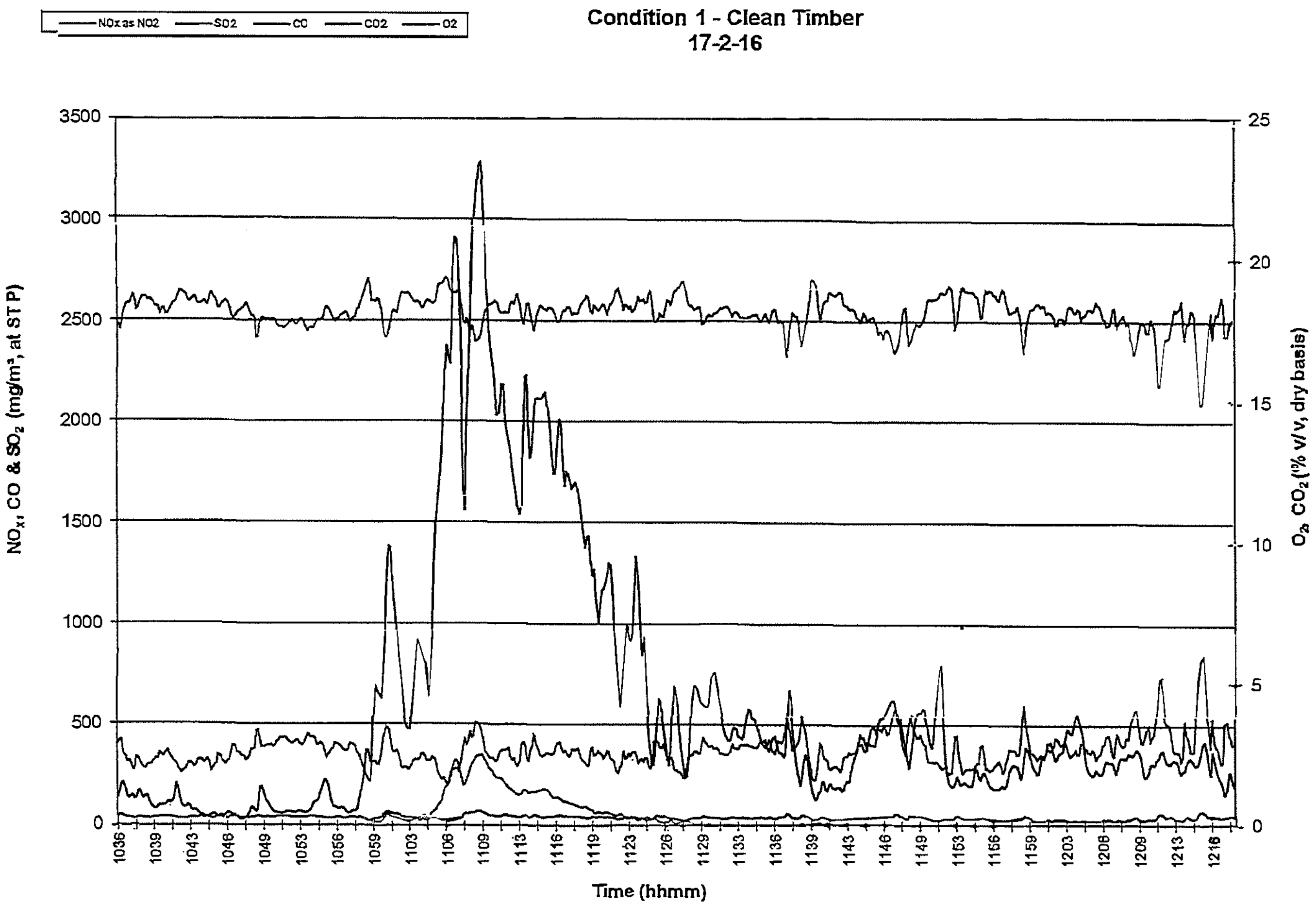
A formal Quality Control program is in place at Ektimo to monitor analyses performed in the laboratory and sampling conducted in the field. The program is designed to check where appropriate; the sampling reproducibility, analytical method, accuracy, precision and the performance of the analyst. The Laboratory Manager is responsible for the administration and maintenance of this program.

## 5 DEFINITIONS

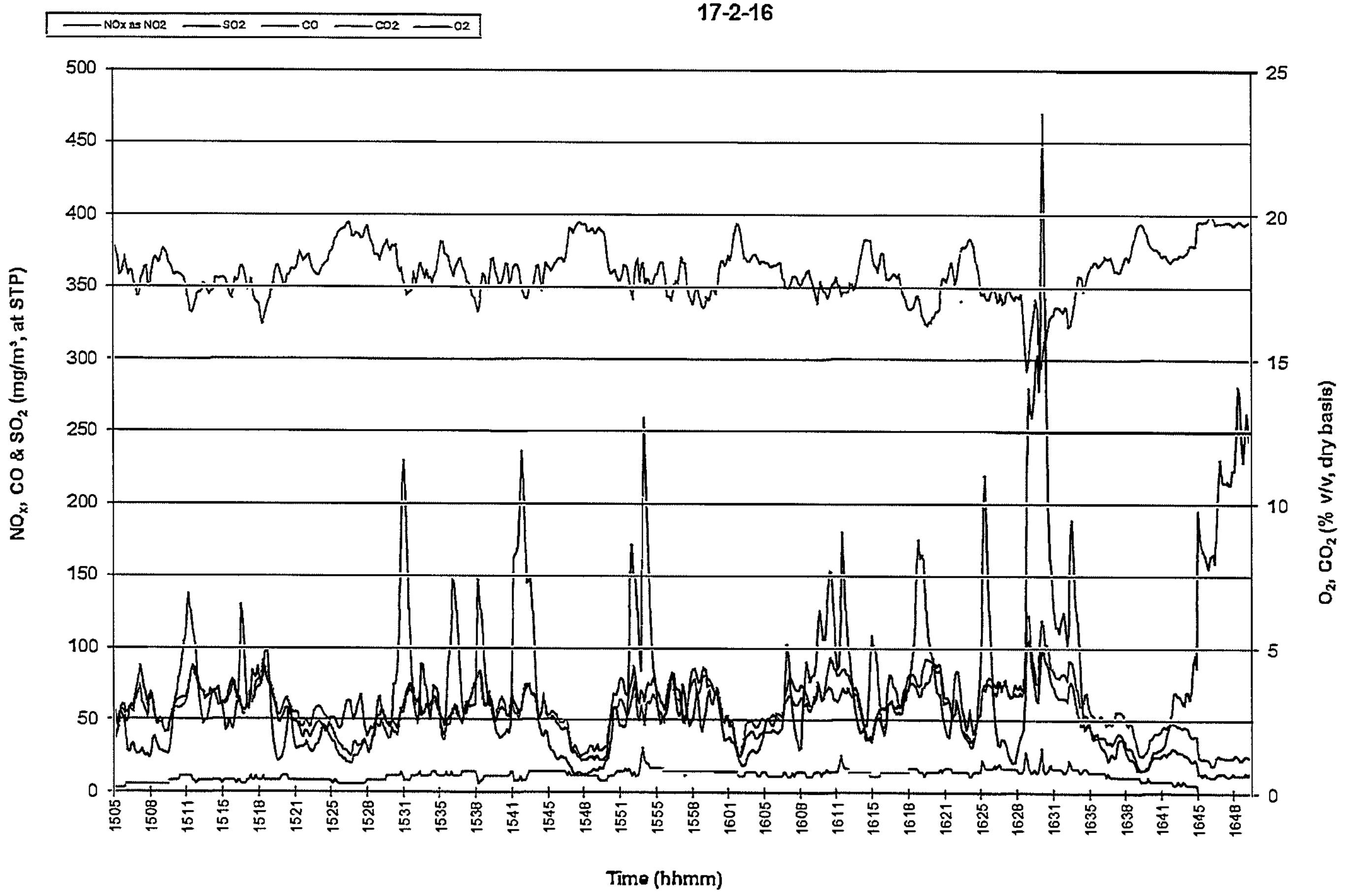
The following symbols and abbreviations may be used in this test report:

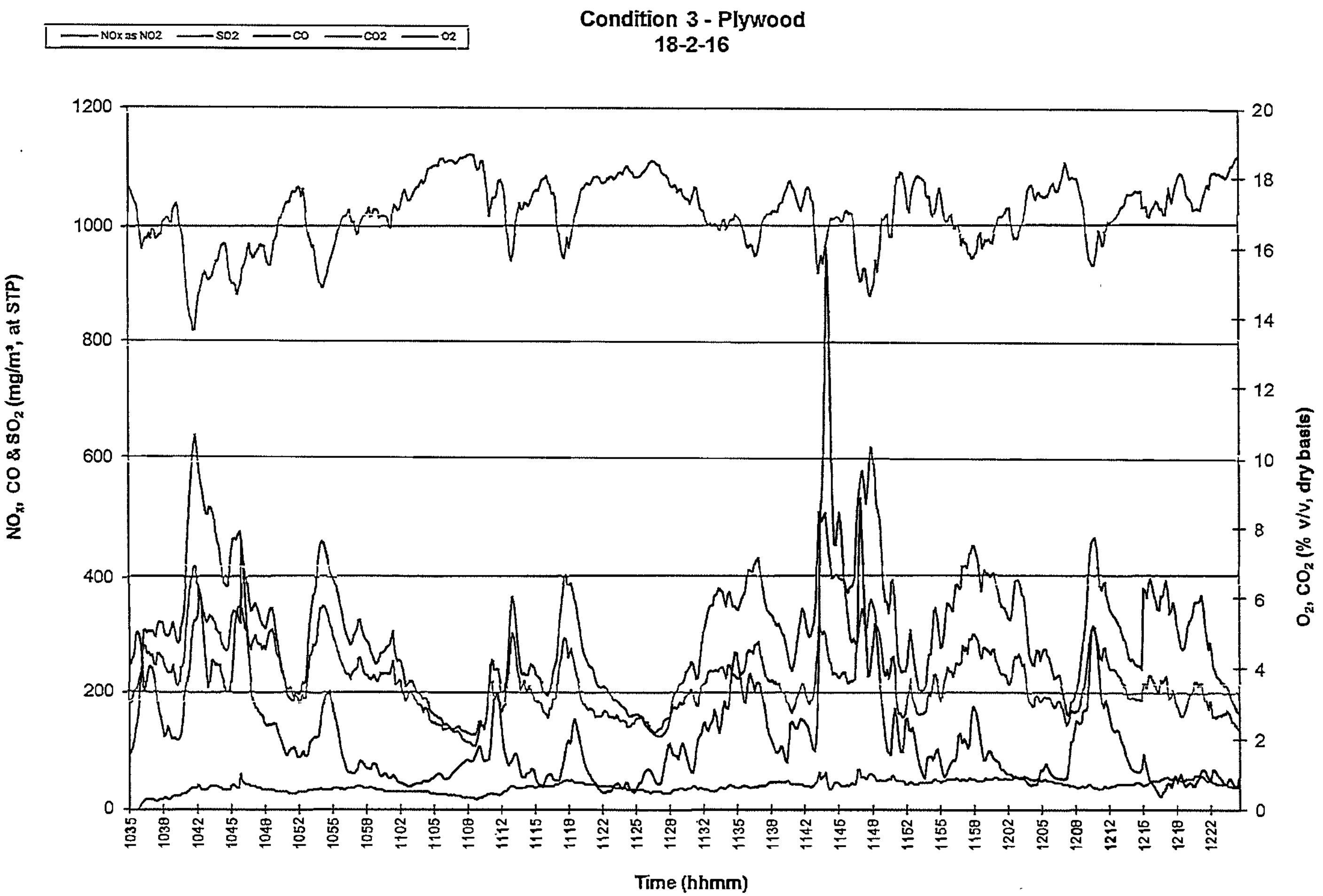
| | |
|---|---|
| STP | Standard temperature and pressure. Gas volumes and concentrations are expressed on a dry basis at 0°C, at discharge oxygen concentration and an absolute pressure of 101.325 kPa, unless otherwise specified. |
| Disturbance | A flow obstruction or instability in the direction of the flow which may impede accurate flow determination. This includes centrifugal fans, axial fans, partially closed or closed dampers, louvres, bends, connections, junctions, direction changes or changes in pipe diameter. |
| VOC | Any chemical compound based on carbon with a vapour pressure of at least 0.010 kPa at 25°C or having a corresponding volatility under the particular conditions of use. These compounds may contain oxygen, nitrogen and other elements, but specifically excluded are carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonate salts. |
| TOC | The sum of all compounds of carbon which contain at least one carbon to carbon bond, plus methane and its derivatives. |
| OU | The number of odour units per unit of volume. The numerical value of the odour concentration is equal to the number of dilutions to arrive at the odour threshold (50% panel response). |
| $PM_{2.5}$ | Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 2.5 microns (µm). |
| $PM_{10}$ | Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 10 microns (µm). |
| BSP | British standard pipe |
| NT | Not tested or results not required |
| NA | Not applicable |
| $D_{50}$ | 'Cut size' of a cyclone defined as the particle diameter at which the cyclone achieves a 50% collection efficiency i.e. half of the particles are retained by the cyclone and half are not and pass through it to the next stage. The $D_{50}$ method simplifies the capture efficiency distribution by assuming that a given cyclone stage captures all of the particles with a diameter equal to or greater than the $D_{50}$ of that cyclone and less than the $D_{50}$ of the preceding cyclone. |
| D | Duct diameter or equivalent duct diameter for rectangular ducts |
| < | Less than |
| > | Greater than |
| ≥ | Greater than or equal to |
| ~ | Approximately |
| CEM | Continuous Emission Monitoring |
| CEMS | Continuous Emission Monitoring System |
| DER | WA Department of Environment & Regulation |
| DECC | Department of Environment & Climate Change (NSW) |
| EPA | Environment Protection Authority |
| FTIR | Fourier Transform Infra-Red |
| NATA | National Association of Testing Authorities |
| RATA | Relative Accuracy Test Audit |
| AS | Australian Standard |
| USEPA | United States Environmental Protection Agency |
| Vic EPA | Victorian Environment Protection Authority |
| ISC | Intersociety committee, Methods of Air Sampling and Analysis |
| ISO | International Organisation for Standardisation |
| APHA | American public health association, Standard Methods for the Examination of Water and Waste Water |
| CARB | Californian Air Resources Board |
| TM | Test Method |
| OM | Other approved method |
| CTM | Conditional test method |
| VDI | Verein Deutscher Ingenieure (Association of German Engineers) |
| NIOSH | National Institute of Occupational Safety and Health |
| XRD | X-ray Diffractometry |

## 5.1 Appendix 1 - Combustion Gas Charts

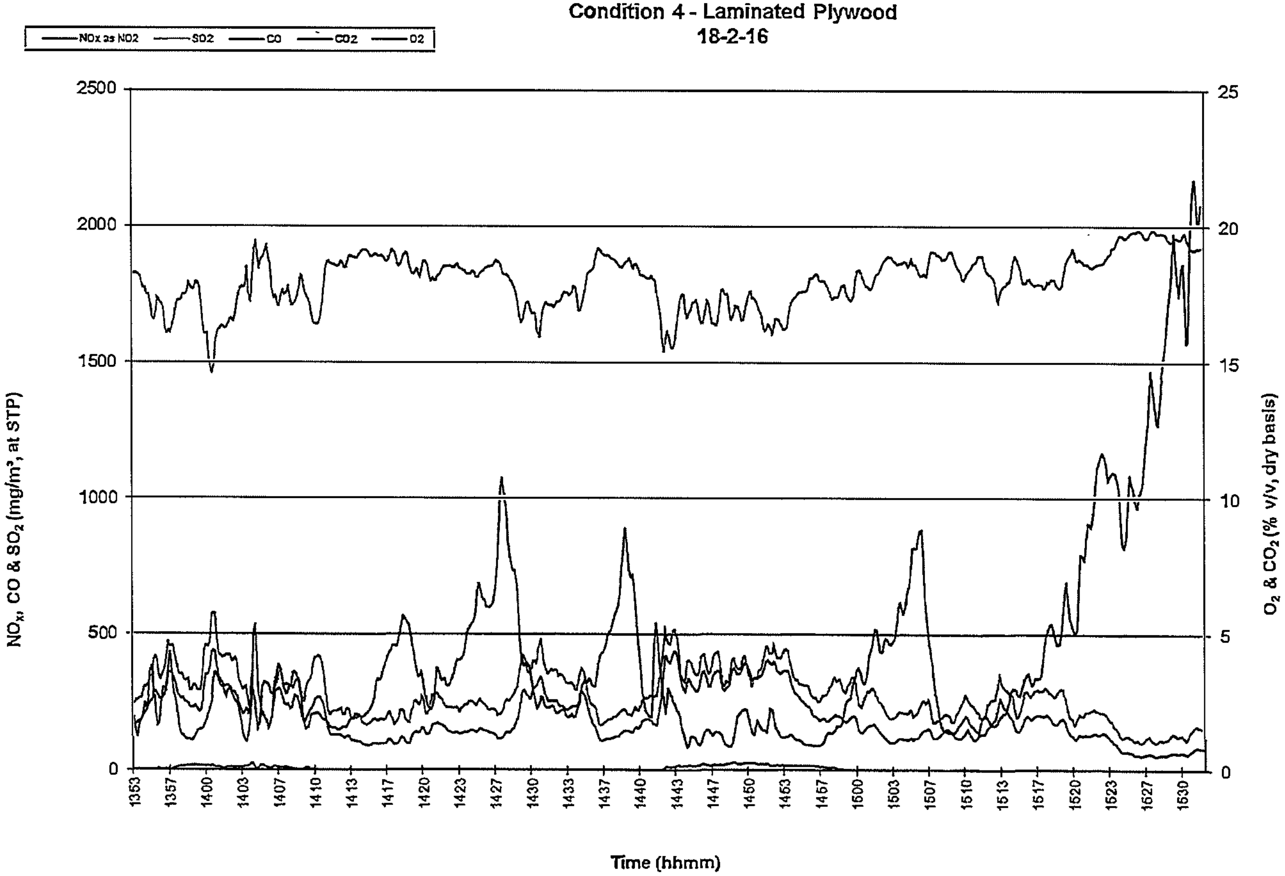


**Condition 2 - Treated Timber**
**17-2-16**




Condition 3 - Plywood
18-2-16
NOx as NO2
SO2
CO
CO2
O2
NOx, CO & SO2 (mg/m³, at STP)
O2, CO2 (% v/v, dry basis)
Time (hhmm)
1200
1000
800
600
400
200
0
20
18
16
14
12
10
8
6
4
2
0
1035
1038
1042
1045
1048
1052
1055
1058
1102
1105
1108
1112
1115
1118
1122
1125
1128
1132
1135
1138
1142
1145
1148
1152
1155
1158
1202
1205
1208
1212
1215
1218
1222

Condition 4 - Laminated Plywood
18-2-16



## Mike Lyons & Associates Pty Ltd

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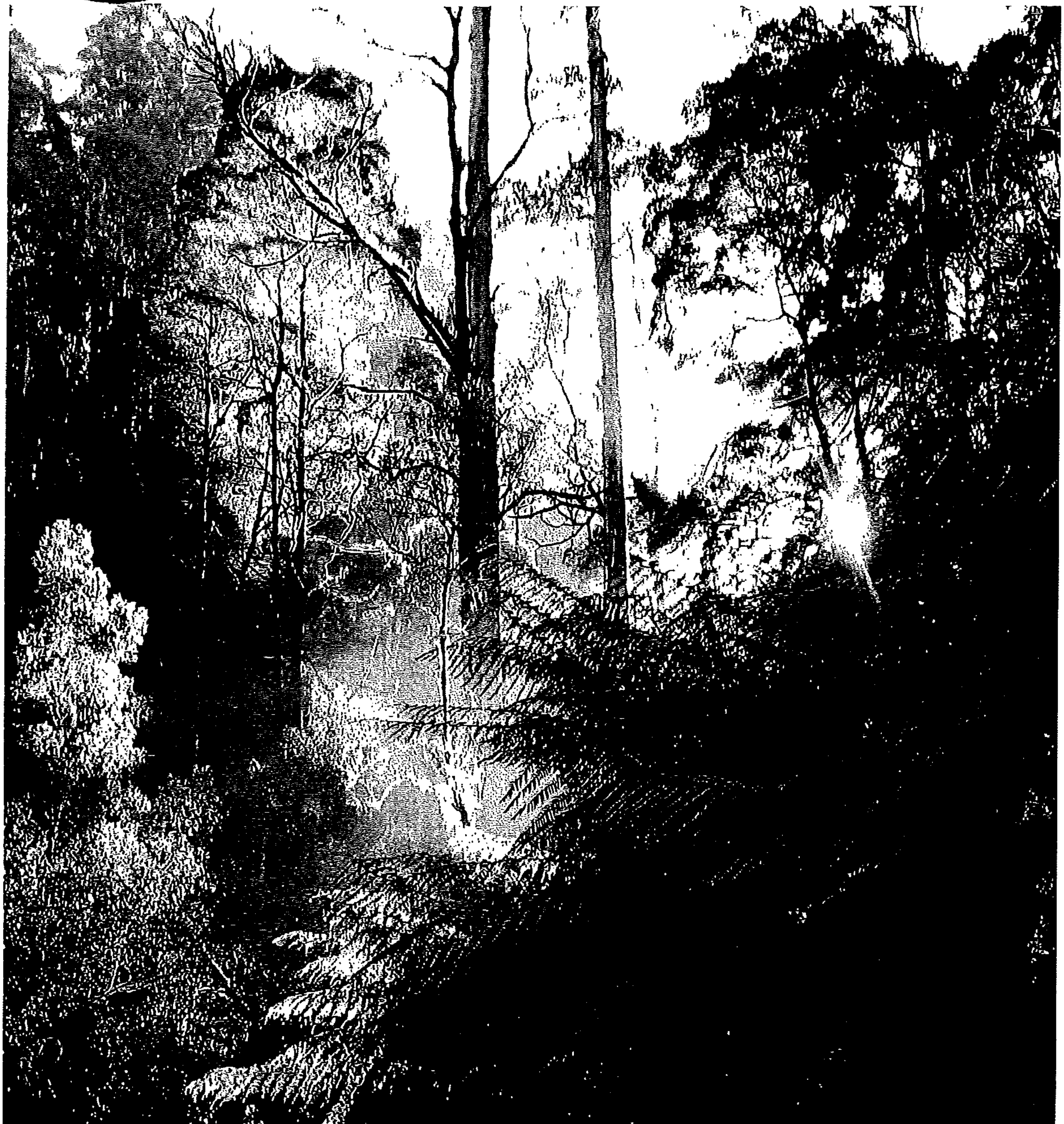

**ACT Waste Feasibility Study**

**Territorial and Municipal Services Directorate**

| | |
|---|---|
| **Premises** | **ACT Recycling Pty Ltd** |
| **Address** | **499 Mugga Lane, Symonston, ACT 2609** |
| **Our reference** | **MA3712** |
| **Date** | **2$^{nd}$ May 2016** |

# TABLE OF CONTENTS

## Executive Summary

This review is intended to be read in conjunction with Ektimo Pty Ltd report #R002410 dated 2nd May 2016.

Tests were carried out on 17th – 18th February 2016 for the ACT Waste Feasibility Study and are intended to be utilised to seek ACT EPA approval for subsequent licensing of the Mugga Lane site. Currently this site is only licensed for disposal of clean timber using a model S119 Firebox from Air Burners Inc.

In order to examine the feasibility of extending the range of material suitable for on-site destruction, tests of emissions and ash deposits were performed under four scenarios:

1. Selected clean timber and logs – as a baseline for comparison
2. Painted timbers with mixed industrial wood waste
3. Clean plywood and particle board
4. Laminates including form release board

The following tests were performed by Ektimo Pty Ltd, a NATA accredited sampling and testing laboratory, on each of the above parameters:

- Exhaust emission characteristics – dimensions, temperature, velocity, flow rate.
- Permanent gases – continuous instrumental monitoring for combustion products - CO, $CO_2$, $O_2$, $NO_x$, $SO_2$ and $H_2O$.
- Particulate emissions – Total solid particulates, analysed for metal/elemental content. Test duration 1.5 - 2 hours.
- Organics – products of the thermal breakdown of wood, analysed by Gas Chromatography / Mass Spectrometry. Test duration 1.5 - 2 hours.
- Odour – sampled from scenarios 1-3 only.
- Ash deposits – analysed for metal/elemental content. Sampled at the end of each test scenario.

Test results are discussed in full in the body of the report under each of the above headings. Summaries of the discussions from each section are presented in the same order.

**Emission characteristics:**

*Temperature* – average approximately 350°C for scenarios #1, #2 and #4, but cooler (200°C) for #3. This was caused by the nature of the flat sheets of particle board, which restricted air access and slowed the burning process.

*Flow rate* - average approximately 250 – 350 $m^3$/min for scenarios #1, #2 and #4, but slower (230 $m^3$/min) for #3. This was also caused by the nature of the flat sheets of particle board, which restricted air access and slowed the burning process.

*Feed rate* - approximately 3.8 - 4.2 tonnes/hour for scenarios #1, #2 and #4, but slower (3.3 tonnes/hour) for #3. This was also caused by the slower burning process.

The slight variations between the four scenarios are not significant, and only reflect the differences in burning characteristics of the feed stocks.

**Permanent Gases**:

*Primary combustion gases* – scenarios #1, #2 and #4, were similar - $CO_2$ 2.8% and $O_2$ 18.1% but $CO_2$ 3.7% and $O_2$ 17.0% for #3.

*Secondary combustion gases* – CO was found to be the highest in the baseline test (#1– 610 mg/$m^3$). This was probably caused by the higher water content of the logs, which would promote the "water gas reaction". In the laminate test (#4– 440 mg/$m^3$), the CO was probably due to higher organics content being thermally broken down.

*Secondary combustion gases* – $NO_x$ was found to be the highest in tests #3 and #4, caused by significant quantities of urea, melamine and other nitrogen rich compounds typically found in particle boards and laminates.

*Secondary combustion gases* – $SO_2$ was insignificant and relatively low in all scenarios. None of the above gases are emitted in sufficient quantities to cause concern on or off site.

**Particulate emissions:**

*Total particulates* – relatively low in all scenarios, the highest being from #3, which operated at a lower temperature. No opacity or smoke was observed except for a few minutes at the start of the operation, and slight emissions during the time of loading new feedstock.

*Particle size* – micrographs show that the majority of particle mass is concentrated in the range of 40 - 120µm. Consequently, $PM_{10}$ represents about 4% and $PM_{2.5}$ represents about 2% of the total solid particulates.

*Elemental composition* - A significant number of metals were below or close to their limits of detection in all four test conditions. In tests #1,#3 and #4, there were no metals or elements detected that would cause any significant effect.

However, in test #2 (mixed industrial wood waste), some heavy metals were found. The main element of note was Arsenic, which originated in the treated wood fraction of the mixture. The other elements (chromium and copper), which are normally present in standard wood treatments, although higher than the baseline test, were not found at such significant levels.

The main concern is for the safety of workers on site and protection of the environment in sensitive areas off site. A generalised Aermod plume dispersion model was produced to predict the probable ground level concentrations of arsenic at varying distances from the source. It was found that the arsenic level at any position on site would be below 1.5% of the Worksafe 8-hour time weighted average exposure standard.

For off-site compliance with Victorian SEPP design ground level criteria or NSW Impact assessment criteria, the unit would need to be at least 200 metres from any residential or sensitive areas. The Mugga Lane site would be ideal for this buffer distance. Alternatively, the elimination of treated materials could be accomplished by the use of a hand-held XRF analyser.

**Organics:**

All substances were found to be below the detectable limit (0.4 mg/m$^3$) in all tests, with the exception of a small amount of benzene, which originated in the baseline test. The laminates and particle boards, with their high loading of organics, showed little or no VOC emission.

Using the Aermod modelling process as used for heavy metal emissions, the maximum GLC caused by the emission of benzene is 0.1923 µg/m$^3$ which is too low to cause any exceedance of Worksafe (3200 µg/m$^3$)or SEPP (53 µg/m$^3$) criteria.

**Odour:**

Using the Aermod modelling process as above, the maximum GLC caused by the emission of the highest odour (264,000 ouv/min from test #3) is 0.46ou. No appreciable odour should be detected either on or off site.

**Ash:**

The ash from tests #1,#3 and #4 contain no appreciable "heavy metals" or other elements of concern.

However, the ash from the mixed treated timber (test #2) contained high concentrations of arsenic, chromium and copper, with lesser concentrations of lead and zinc. This would not be suitable for composting or similar avenues of disposal.

Using an XRF analyser, both feedstock and ash can be screened for arsenic, chromium, copper (CCA) and other wood treatments.

The final outcome of this test series suggests that tests #1,#3 and #4 would pose no problems with respect to permanent gases, gaseous combustion products, particulates, heavy metals, organics and odour receptors either on or off site.

In the case of test #2:

- As above, no problems would be expected from permanent gases, gaseous combustion products, organics and odour, but concentrations of arsenic in the particulate phase are of concern.

  The destruction of mixed painted/treated demolition waste could be safely continued without risk of affecting workers on site, but would require a buffer zone of at least 200 metres for the protection of sensitive off-site residential environments.

  However, the ash would be unacceptable for composting and would need to be treated appropriately before disposal.

- Alternatively, by identifying treated material using XRF instrumental units, all treated timber could be removed, allowing acceptable material to be destroyed, and the ash would then be safe for regular disposal.

## Project Description

The ACT Waste Feasibility study is currently exploring potential options in relation to contaminated wood treatment technologies. Specifically, this is dealing with the current stockpile at the premises of ACT Recycling Pty Ltd at 499 Mugga Lane Symonston, where there is an ongoing issue with the disposal of contaminated wood from the construction and demolition sector.

Figure 1. Typical wood piles awaiting disposal

## Current situation

Under ACT Authorisation #0575, the site is only permitted to dispose of clean timber using their model S119 firebox from Air Burners Inc. This will only address a small proportion of this increasing stockpile, and in order to extend the range of disposable materials, a series of tests have now been carried out by Ektimo Pty Ltd – a NATA approved sampling and testing laboratory.

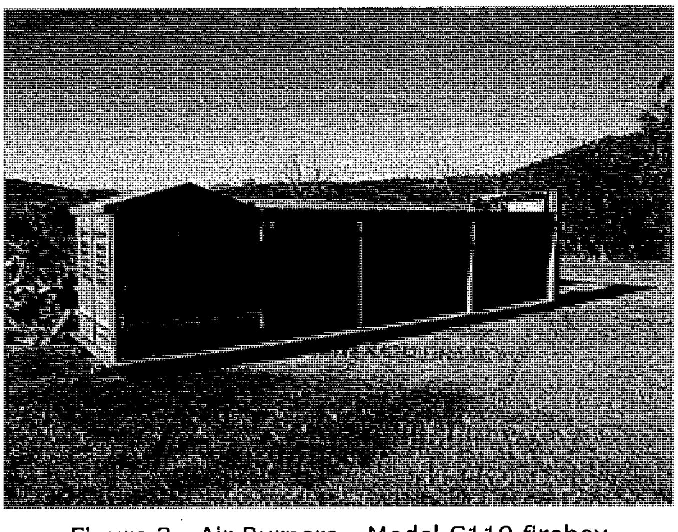

Figure 2. Air Burners - Model S119 firebox

## Scope of testing

Tests were performed by Ektimo Pty Ltd - NATA Accredited Laboratory No. 14601. Report Number R002410 accompanies this report. Measurements from the Air Burners Inc. Model S119 Firebox were carried out to demonstrate the emissions to air and ash deposits resulting from the destruction of four classes of building demolition waste.

These classes were:

1. Selected clean timber
2. Mixed industrial wood waste.
3. Clean particle board and plywood
4. Laminates and coated "form release" materials

### Emission parameters

- Dimensions (m)
- Temperature (°C)
- Flow rate, actual ($m^3$/sec)
- Flow rate at NTP, wet ($Nm^3$/sec)
- Flow rate at NTP, dry ($Nm^3$/sec)
- Velocity (m/s)
- Moisture (%)

### Airborne emissions

- Permanent Gases – analysed by real time continuous instrumental readings for CO, $CO_2$, $NO_x$, $SO_2$ and $O_2$
- Airborne solids – Particulate matter analysed for metal content using inductively coupled plasma.
- Organic combustion products from the thermal breakdown of wood analysed using gas chromatography/mass spectrometry.
- Odour concentration determined using panel assessment method AS4323.3. .No odour samples were taken from class 4 – Laminates.

### Ash deposits

- Ash deposits were analysed for any residual heavy metals which potentially could be found in coatings, paints, treated wood etc.

## Permits

The site is currently operating under ACT Environmental Authorisation #0575 - Environment Protection Act 1997.

Table 4 of this document refers specifically to firebox operation:

**Authorisation No. 0575**

***TABLE 4: AIR BURNER OPERATION.***

| Requirement |
|---|
| The Authorisation holder shall ensure:<br>• the feedstock for the airburner shall only comprise natural timbers; and<br>• the equipment is operated in accordance with the manufactures instructions.<br>Ash waste from the air burner must be taken to a facility authorised/ licensed to accept such waste and documentary evidence of the disposal kept by the Authorisation Holder.<br>Any other beneficial reuse of the ash will require prior written approval by the Authority. |

To enable testing of feedstock other than "natural timbers" as outlined under Scope of Testing – permission was granted from the Department of Environment and Dangerous Substances Licensing.

Email dated 5th February 2016 – Tom Nilsen

**From:** Nilsen, Tom
**Sent:** Friday, 5 February 2016 5:47 PM
**To:** 'Theo Samarkos'
**Cc:** Power, David
**Subject:** FW: Air Burners - ACT Recycling

Dear Theo,

Thank you for the opportunity to be involved in exploring best practice options for management of waste timber at Block part 2114 Jerrabomberra, ACT. The activity is closely associated with Environmental Authorisation no.0575 (EA 0575). The proactive approach of ACT Recycling P/L to contact the ACT Environment Protection Authority is appreciated, particularly given interstate and overseas interest.

This is to confirm in-principle support for the testing of the airburner with various grades of waste timber, in addition to requirements of EA0575. Please note the following requirements of in-principle approval:

- Testing operations must follow procedure described in Brian O'Connor email of 27 January 2015 (below) and document 'Proposal for Testing Air Curtain Burner';
- An Authorised Officer will be required to attend the tests for observation/advisory purposes;
- Report of test findings to be provided to Environment Regulation by email to environment.protection@act.gov.au within two months of testing or at an alternative date agreed to in writing by Environment Regulation; and
- ACT Recycling are required to comment on test findings, specifically on the capacity to manage timber waste stream in terms of approximate volume/load reduction.

Regards
Tom

Tom Nilsen
Manager, Environment and Dangerous Substances Licensing
p 02 6205 4644 | e tom.nilsen@act.gov.au | [redacted]
Construction, Environment and Workplace Protection | Access Canberra | ACT Government
http://www.environment.act.gov.au/

## Personnel present at tests

***Program Direction - ACT Waste Feasibility Study***

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Marlese van Lille – (02) 6207 5361

***ACT EPA Licensing***

David Power - Manager Environmental Standards, Environment Protection & Water Regulation
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***EPA Victoria***

Wendy Tao – Project Manager – Works Approval
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***Air Burners Inc.***

Brian O'Connor
President +1772 341 9858, boconnor@airburners.com

***Project Manager – Mike Lyons & Associates Pty Ltd***

Mike Lyons
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***Sampling and Analysis - Ektimo Pty Ltd***

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***Firebox facility – ACT Recycling Pty Ltd***

Manuel Samarkos
(02) 6239 7916, manuel@actrecycling.com.au

Theo Samarkos
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***Firebox supervision – Organic Matter Solutions Pty Ltd***

[redacted]@organicmattersolutions.com

## Location

All tests were carried out on the premises of ACT Recycling Pty Ltd at their 499 Mugga Lane, Symonston site. The testing area was located at the Northern end of the property.

**Testing area**

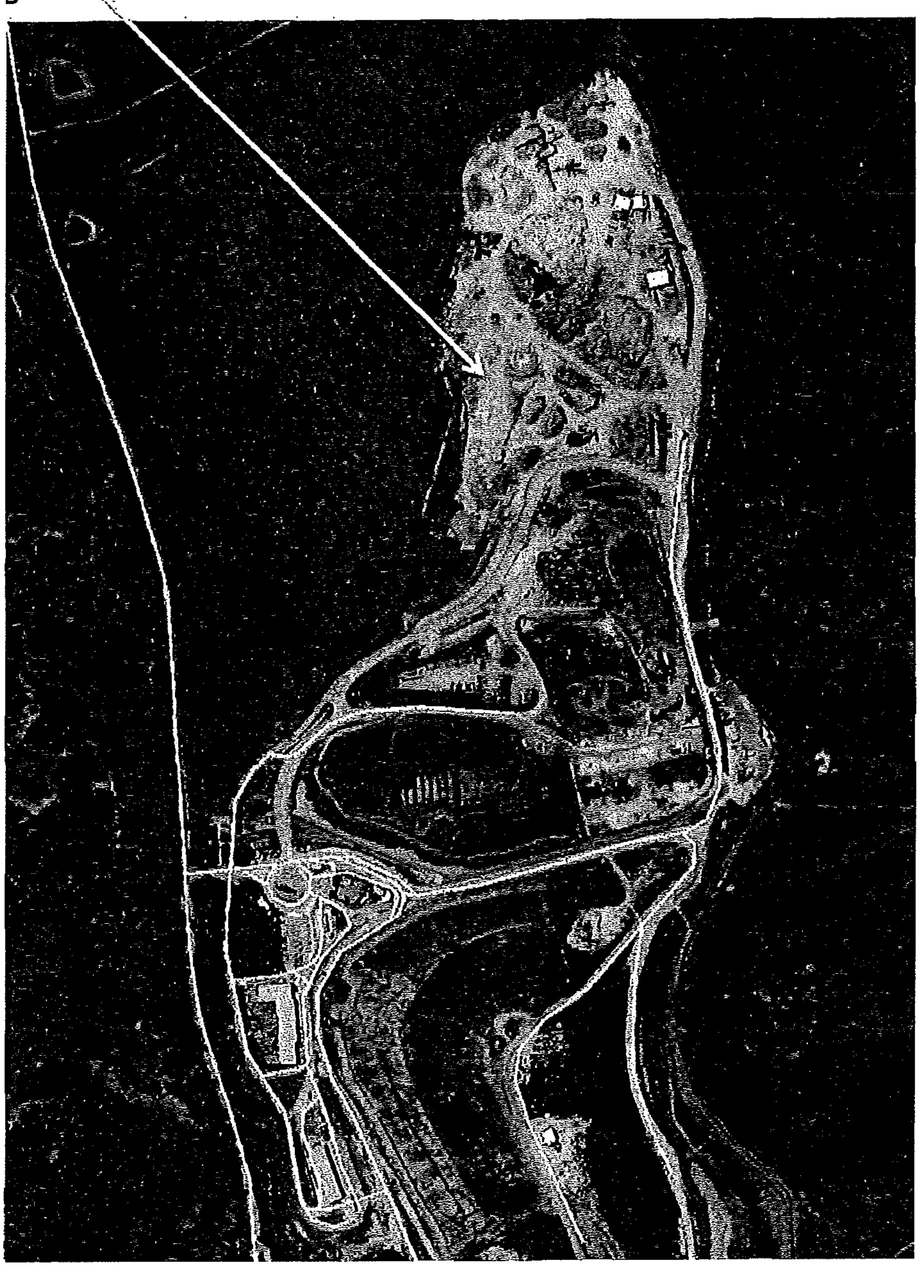

Figure 3. ACT Recycling - Mugga Lane site

## Testing - Wednesday 17th February 2016:

### Clean Wood Waste

Includes clean vegetative waste and clean industrial wood waste with no coatings or treatment. Waste stream was manually sorted to insure no painted, treated or glued woods of any description were present and none of the material was obviously contaminated by spillage or otherwise. Clean industrial pallets were included and these pallets did include metal fasteners such as nails and staples.


Figure 4. Condition #1 - Clean wood

### Mixed Industrial Wood Waste

Mixture of wood scrap including building demolition timber, pallets, wood boxes, etc. This waste stream did include paint coatings, small pieces of drywall, treated wood, nails and some spillage on the pallets. This wood waste stream was manually sorted to insure that the most obvious treated woods such as railway sleepers, marine pilings were removed. Additionally, all plywood and particle board were removed for separate testing.

Figure 5. Condition #2 - Mixed wood waste

## Testing - Thursday 18th February 2016:

### Mixed Particle Board / Plywood Waste

Mixture of chip and particle compressed sheet stock, most broken into less than one square meter pieces. Particle Board waste stream was manually sorted to remove any plywood with non-wood laminates. Particle board did include some painted coatings and spillage.

Figure 6. Condition #3 - Clean particle board/ plywood

**Laminated Waste**

Mixture of particle board stock 1-2 meters square in size with laminations on one or both sides. Waste stream was manually sorted to remove any clean particle board or any other timber waste. Laminations were predominately a black form release agent (black laminated i.e., "FORM RELEASE 88™") used in the construction industry for concrete forming. Waste stream also included some plastic laminated board as commonly used in the furniture industry.

Figure 7. Condition #4 - Full laminates and black form release

## Test Results

### Flow rates and feed stock supply rates

| Test | Feed rate | Flow rate, dry | Flow rate, wet |
|---|---|---|---|
| | MT/hr | $Nm^3/min$ | $Nm^3/min$ |
| Clean wood waste | 4.2 | 240 | 252 |
| Mixed industrial wood waste | 3.8 | 246 | 252 |
| Clean particle board/plywood | 3.3 | 228 | 240 |
| Laminated waste | 3.75 | 330 | 336 |

Table 1. Summary of feed and flow rates

**Discussion**

The S119 unit is optimised for a feed rate of about 4 metric tons/hour. The above table shows the measured feed rates and total firebox flow rates.

The flow rates were sampled from a grid consisting of 5 rows with 7 sampling points in each row. There was considerable increase of temperature from the first row closest to the manifold to the $5^{th}$ row at the front of the box. The greatest flow rate was also observed from the front of the box.

Consequently, sampling was performed from this location, and remained in the same position for all tests.

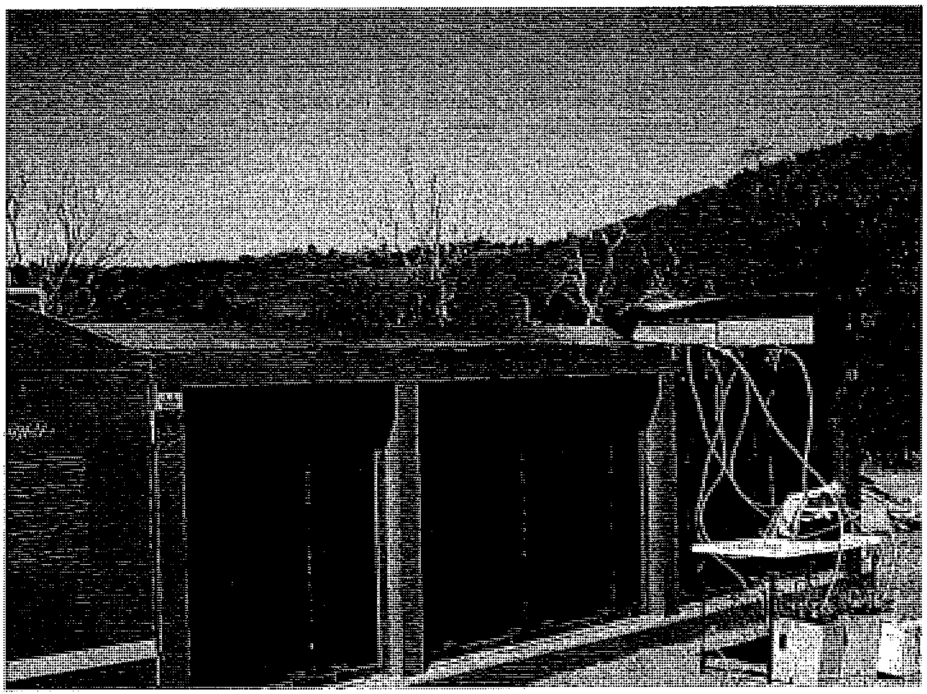

Figure 8. Sampling position

## Permanent gases

| Test | Permanent Gases | | |
|---|---|---|---|
| | CO | $NO_x$ | $SO_2$ |
| *Concentrations - mg/Nm³* | | | |
| Clean wood waste | 610 | 40 | 33 |
| Mixed industrial wood waste | 77 | 54 | 12 |
| Clean particle board/plywood | 130 | 300 | 39 |
| Laminated waste | 440 | 200 | 4.7 |
| *Mass Rates - g/min* | | | |
| Clean wood waste | 146 | 9.6 | 7.9 |
| Mixed industrial wood waste | 18.9 | 13.3 | 3.0 |
| Clean particle board/plywood | 29.6 | 68.4 | 8.9 |
| Laminated waste | 145 | 66.0 | 1.6 |

| Combustion Gases | | |
|---|---|---|
| % $CO_2$ | % $O_2$ | % $H_2O$ |
| *Concentrations - %* | | |
| 2.7 | 18.2 | 4.4 |
| 2.8 | 18.1 | 2.0 |
| 3.7 | 17.0 | 4.6 |
| 2.8 | 18.0 | 2.5 |

Table 2. Summary of total gaseous emissions

### Discussion

Combustion gases ($CO_2$, $O_2$ and $H_2O$) were continually monitored and these remained stable, showing relatively little variation from test to test.

The permanent gases were also continually monitored, but these fluctuated depending on the loading frequency, size and nature of feed stock and moisture content.

*Carbon monoxide (CO)* – maximum emission occurred with clean wood, probably caused by the large logs which were included in the feed stock. These have a higher water content and would take longer to reach their maximum temperature. The "water gas" reaction: $C + H_2O = CO + H_2$ is probably the major source of CO in this case.

The lowest CO emission came from the mixed industrial waste, which consisted of relatively small pieces, and hence burned quickly. The higher the temperature and the lower the water content, the less CO will be emitted.

*Oxides of nitrogen ($NO_x$)* – this will be generated from two sources:

- From combustion, with high core temperatures (averaging 1200-1300°C) causing a reaction between atmospheric nitrogen and oxygen.
- From the oxidation of nitrogen based compounds such as urea and melamine commonly used in the manufacture of particle boards.

It can be seen that the two types of particle board yielded the highest $NO_x$ emissions

*Sulfur dioxide ($SO_2$)* - emissions of this substance are relatively trivial.

The highest recorded emissions of CO, $SO_2$ and $NO_x$ in these tests are too low to cause any exceedence of worksafe or off-site ground level concentration criteria.

## Total Particulates

| Test | Total Pcls |
|---|---|
| *Concentrations - mg/Nm³* | |
| Clean wood waste | 24.0 |
| Mixed industrial wood waste | 33.0 |
| Clean particle board/plywood | 47.0 |
| Laminated waste | 32.0 |
| *Mass Rates - g/min* | |
| Clean wood waste | 5.8 |
| Mixed industrial wood waste | 8.1 |
| Clean particle board/plywood | 10.7 |
| Laminated waste | 10.6 |
| | |
| *Feedstock ratios - kg/MT* | |
| Clean wood waste | 0.082 |
| Mixed industrial wood waste | 0.128 |
| Clean particle board/plywood | 0.195 |
| Laminated waste | 0.169 |
| *Feedstock ratios - lbs/UST* | |
| Clean wood waste | 0.165 |
| Mixed industrial wood waste | 0.256 |
| Clean particle board/plywood | 0.390 |
| Laminated waste | 0.338 |

Table 3. Summary of total particulate emission

**Discussion**

The ratio of total particulate matter to feed rate is limited by USEPA at "1 lb/ton", which equates to 0.5 kg per metric tonne. The feedstock ratios shown above are well within this requirement.

A further requirement is a limit to the opacity of any emission when observed over a fixed period of time (USEPA #9). During the tests, apart from a few minutes at the start up, and at the moment of adding feedstock to the fire, there was little or no visible smoke. A Ringelmann chart was used as a reference, and no reading above zero was observed throughout the test sequence.

The tests show that both feedstock ratios and opacity requirements are met in all of the nominated conditions.

**Particle size**

Samples were taken for microscopic analysis in order to determine typical particle sizes in the collected filters. The emission consists of a few large agglomerates (50-100μm+), which strongly skews the weight distribution, consequently the proportion by weight of $PM_{10}$ (4.06%) and $PM_{2.5}$ (1.8%) is very small.

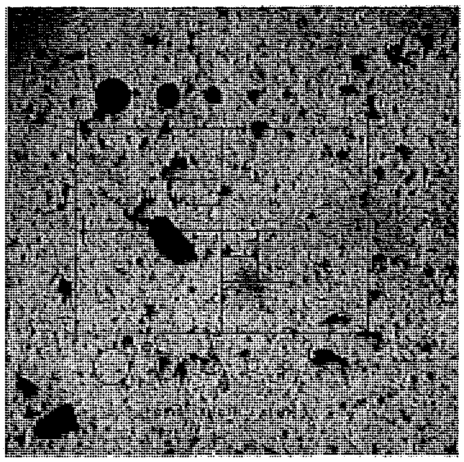

Figure 9. Typical micrograph of particulate emission

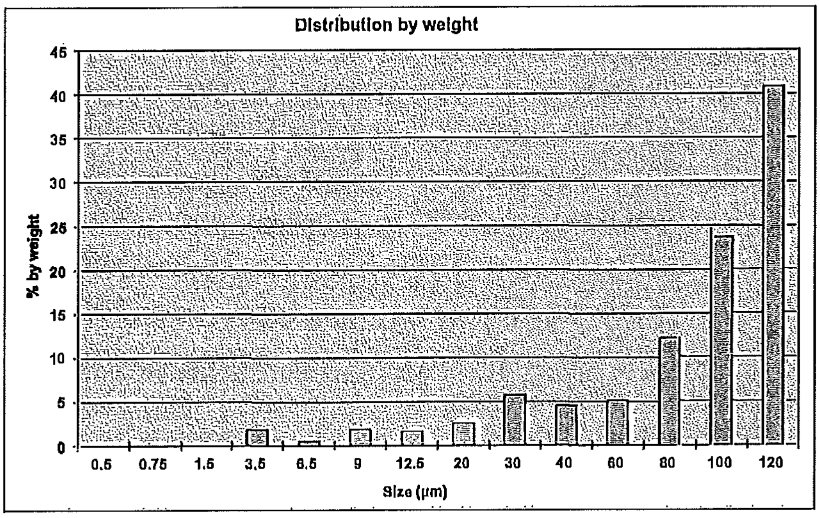


Figure 10. Typical particulate size distribution

**Discussion**

Given the small proportion of $PM_{10}$ and $PM_{2.5}$, the highest of the total particulate emissions (47 mg/m$^3$), will represent an actual $PM_{10}$ emission of only 1.9 mg/m$^3$ and $PM_{2.5}$ of 0.85 mg/m$^3$.

## Metals analysis

| Element | Test #1 | Test #2 | Test #3 | Test #4 |
|---|---|---|---|---|
| *Emission concentrations in mg/m³* | | | | |
| Aluminium | 0.033 | 0.14 | 0.36 | 0.12 |
| Antimony | <0.005 | 0.012 | <0.003 | <0.003 |
| Arsenic | 0.0046 | 0.76 | 0.03 | 0.003 |
| Barium | 0.0074 | 0.0052 | 0.008 | 0.0067 |
| Beryllium | <0.001 | <0.0009 | <0.0009 | <0.0009 |
| Boron | 0.028 | 0.025 | 0.095 | 0.038 |
| Cadmium | <0.0005 | 0.00095 | 0.00094 | 0.0022 |
| Calcium | <0.8 | 0.65 | 1.5 | 0.55 |
| Chromium | 0.0028 | 0.0085 | 0.003 | ≤0.00067 |
| Cobalt | <0.0009 | <0.0006 | <0.0006 | <0.0006 |
| Copper | 0.0094 | 0.011 | 0.0043 | 0.0024 |
| Iron | 0.014 | 0.098 | 0.21 | 0.071 |
| Lead | 0.056 | 0.17 | 0.099 | 0.13 |
| Lithium | 0.00093 | <0.0007 | ≤0.00062 | ≤0.0007 |
| Magnesium | <0.6 | <0.4 | <0.4 | <0.4 |
| Manganese | 0.013 | 0.013 | 0.021 | 0.014 |
| Mercury | <0.001 | <0.0008 | <0.0007 | <0.0007 |
| Molybdenum | <0.001 | <0.0009 | <0.0009 | <0.0009 |
| Nickel | <0.001 | <0.0009 | 0.0015 | <0.0009 |
| Phosphorus | 0.12 | 0.034 | 0.098 | 0.036 |
| Potassium | 4.5 | 0.88 | 1.6 | 2.5 |
| Selenium | <0.005 | <0.003 | <0.003 | <0.003 |
| Silver | <0.0009 | <0.0006 | <0.0006 | <0.0006 |
| Sodium | <0.9 | 0.7300 | 1.1000 | 3.3000 |
| Tin | <0.002 | 0.0059 | 0.0041 | 0.003 |
| Vanadium | <0.001 | <0.0009 | <0.0009 | <0.0009 |
| Zinc | 0.12 | 1.5 | 0.74 | 0.8 |
| Titanium | <0.001 | 0.0044 | 0.012 | 0.0078 |

*Items in red are below detectable limits*

Table 4. Summary of metal concentrations in particulates

### Discussion

The summary above shows that a significant number of metals are below or close to their limits of detection in all four test conditions. It was expected that some heavy metals would be found in the airborne samples and the tests have shown that to be true, but only in the Mixed Industrial Wood Waste (test #2).

The main element of concern is Arsenic. It is believed that the source of this component is pressure treated wood (CCA), although similar levels of Chromium and Copper would also be expected, but these were not found in the airborne fraction to any extent.

As mentioned earlier the "obvious" pressure treated wood pieces were eliminated in the hand sorting by visual inspection. But it is difficult to visually identify all pressure treated timber. Timber used in gardens, fencing and outdoor home patios may be old and weathered and may look very similar to the general building and demolition debris.

| Element | Test #1 | Test #2 | Test #3 | Test #4 |
|---|---|---|---|---|
| *Mass rates in g/min* | | | | |
| Aluminium | 0.0079 | 0.0344 | 0.0821 | 0.0396 |
| Antimony | 0.0012 | 0.0030 | 0.0007 | 0.0010 |
| Arsenic | 0.0011 | 0.1870 | 0.0068 | 0.0010 |
| Barium | 0.0018 | 0.0013 | 0.0018 | 0.0022 |
| Beryllium | 0.0002 | 0.0002 | 0.0002 | 0.0003 |
| Boron | 0.0067 | 0.0062 | 0.0217 | 0.0125 |
| Cadmium | 0.0001 | 0.0002 | 0.0002 | 0.0007 |
| Calcium | 0.1920 | 0.1599 | 0.3420 | 0.1815 |
| Chromium | 0.0007 | 0.0021 | 0.0007 | 0.0002 |
| Cobalt | 0.0002 | 0.0001 | 0.0001 | 0.0002 |
| Copper | 0.0023 | 0.0027 | 0.0010 | 0.0008 |
| Iron | 0.0034 | 0.0241 | 0.0479 | 0.0234 |
| Lead | 0.0134 | 0.0418 | 0.0226 | 0.0429 |
| Lithium | 0.0002 | 0.0002 | 0.0001 | 0.0002 |
| Magnesium | 0.1440 | 0.0984 | 0.0912 | 0.1320 |
| Manganese | 0.0031 | 0.0032 | 0.0048 | 0.0046 |
| Mercury | 0.0002 | 0.0002 | 0.0002 | 0.0002 |
| Molybdenum | 0.0002 | 0.0002 | 0.0002 | 0.0003 |
| Nickel | 0.0002 | 0.0002 | 0.0003 | 0.0003 |
| Phosphorus | 0.0288 | 0.0084 | 0.0223 | 0.0119 |
| Potassium | 1.0800 | 0.2165 | 0.3648 | 0.8250 |
| Selenium | 0.0012 | 0.0007 | 0.0007 | 0.0010 |
| Silver | 0.0002 | 0.0001 | 0.0001 | 0.0002 |
| Sodium | 0.2160 | 0.1796 | 0.2508 | 1.0890 |
| Tin | 0.0005 | 0.0015 | 0.0009 | 0.0010 |
| Vanadium | 0.0002 | 0.0002 | 0.0002 | 0.0003 |
| Zinc | 0.0288 | 0.3690 | 0.1687 | 0.2640 |
| Titanium | 0.0002 | 0.0011 | 0.0027 | 0.0026 |

*Items in red are below detectable limits*

Table 5. Summary of metal mass rates in particulates

## Discussion

The main concern is for the safety of workers on site and protection of the environment in sensitive areas off site. Consequently, a generalised Aermod plume dispersion model was produced, with the intention of identifying the probable ground level concentrations of arsenic at varying distances from the source.

The results were referenced against the Safe Work Australia publication "*Workplace Exposure Standards for Airborne Contaminants, 22 December 2011*" for the consideration of worker safety on-site and the "*Victorian Government Gazette S240-SEPP (AQM) December 2001*" for the protection of sensitive areas off-site.

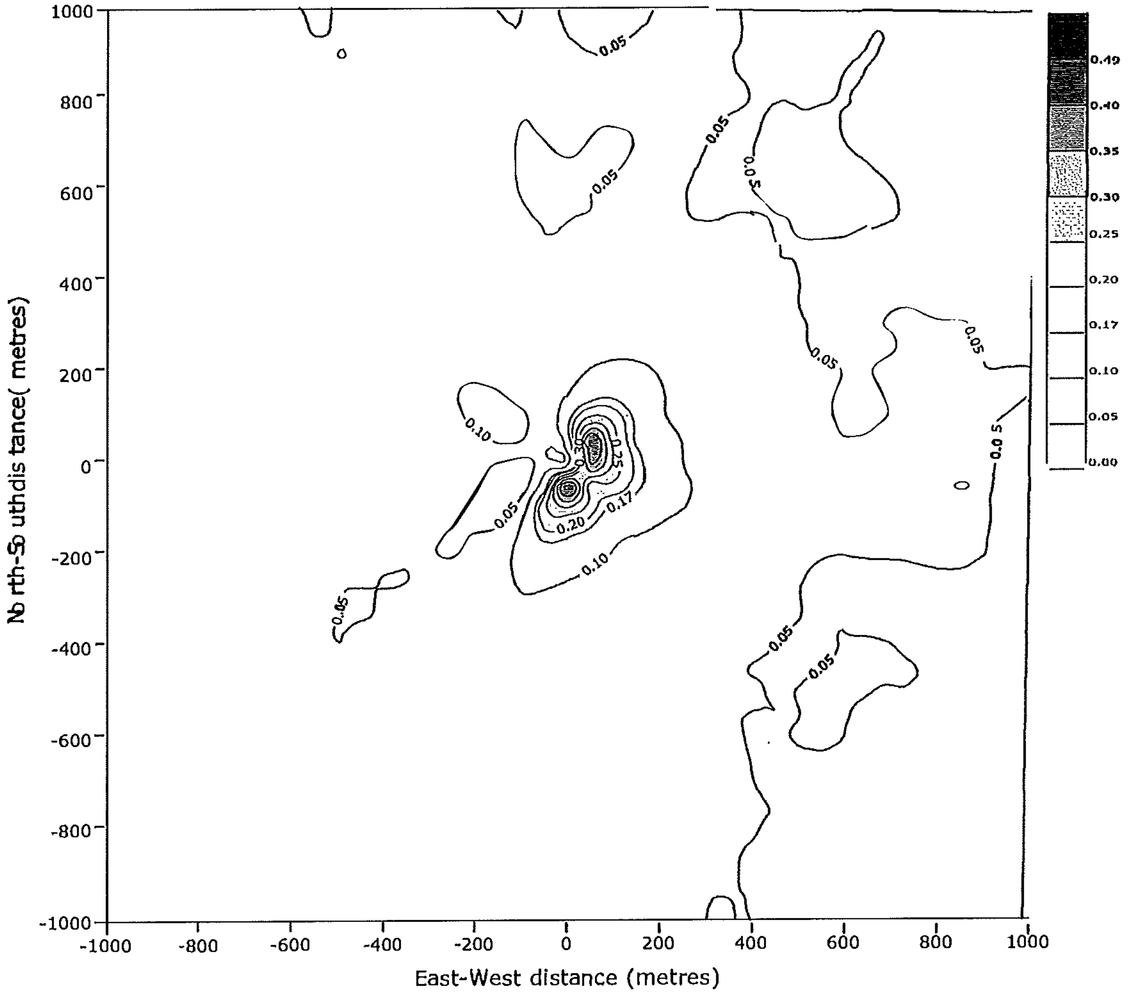


Figure 11. Aermod model showing Arsenic ground level concentrations

## Discussion

The above isopleths are specific for arsenic, and show that provided that no sensitive receptor exists within a radius of 200 metres, compliance with the design criterion specified by the Victorian State Environment Protection Policy of 0.17 µg/m³ can be achieved.

The "9th worst" value from the table of 100 highest ground level concentrations has been determined to be 0.7490 µg/m³. This is only about 1.5% of the Worksafe limit (this being an 8-hour time weighted average of 50 µg/m³) and it is clear that at no location on-site will there be any possibility of a worker being exposed to this concentration.

This result can be improved by the use of a handheld XRF analyser which will readily identify any Arsenic or related elements, both in the timber at the sorting stage and the ash prior to disposal.

| Element | Worksafe | SEPP | Test #1 | Test #2 | Test #3 | Test #4 |
|---|---|---|---|---|---|---|
| *Modelled GLC - 9th Worst (μg/m³)* | | | | | | |
| Aluminium | 1000 | 33.3 | 0.0317 | 0.1380 | 0.3288 | 0.1587 |
| Antimony | 500 | 16.7 | 0.0048 | 0.0118 | 0.0027 | 0.0040 |
| Arsenic | 50 | 0.17 | 0.0044 | 0.7490 | 0.0274 | 0.0040 |
| Barium | 500 | 17 | 0.0071 | 0.0051 | 0.0073 | 0.0089 |
| Beryllium | 2 | 0.007 | 0.0010 | 0.0009 | 0.0008 | 0.0012 |
| Boron | 10000 | 333.3 | 0.0269 | 0.0246 | 0.0868 | 0.0502 |
| Cadmium | 10 | 0.033 | 0.0005 | 0.0009 | 0.0009 | 0.0029 |
| Calcium | 2000 | 66.7 | 0.7692 | 0.6406 | 1.3702 | 0.7272 |
| Chromium$^{VI}$ | 50 | 0.17 | 0.0027 | 0.0084 | 0.0027 | 0.0009 |
| Cobalt | 50 | 1.7 | 0.0009 | 0.0006 | 0.0005 | 0.0008 |
| Copper | 200 | 33 | 0.0090 | 0.0108 | 0.0039 | 0.0032 |
| Iron | 5000 | 166.7 | 0.0135 | 0.0966 | 0.1918 | 0.0939 |
| Lead | 150 | 5.0 | 0.0538 | 0.1675 | 0.0904 | 0.1719 |
| Lithium | 25 | 0.8 | 0.0009 | 0.0007 | 0.0006 | 0.0009 |
| Magnesium | 10000 | 333.3 | 0.5769 | 0.3942 | 0.3654 | 0.5288 |
| Manganese | 1000 | 33.3 | 0.0125 | 0.0128 | 0.0192 | 0.0185 |
| Mercury | 25 | 0.8 | 0.0010 | 0.0008 | 0.0006 | 0.0009 |
| Molybdenum | 5000 | 166.7 | 0.0010 | 0.0009 | 0.0008 | 0.0012 |
| Nickel | 100 | 3.3 | 0.0010 | 0.0009 | 0.0014 | 0.0012 |
| Phosphorus | 1000 | 33.3 | 0.1154 | 0.0335 | 0.0895 | 0.0476 |
| Potassium | 2000 | 66.7 | 4.3269 | 0.8673 | 1.4615 | 3.3053 |
| Selenium | 100 | 3.3 | 0.0048 | 0.0030 | 0.0027 | 0.0040 |
| Silver | 10 | 0.33 | 0.0009 | 0.0006 | 0.0005 | 0.0008 |
| Sodium | 2000 | 66.7 | 0.8654 | 0.7195 | 1.0048 | 4.3630 |
| Tin | 2000 | 66.7 | 0.0019 | 0.0058 | 0.0037 | 0.0040 |
| Vanadium | 50 | 1.7 | 0.0010 | 0.0009 | 0.0008 | 0.0012 |
| Zinc | 5000 | 170 | 0.1154 | 1.4784 | 0.6760 | 1.0577 |
| Titanium | 10000 | 333.3 | 0.0010 | 0.0043 | 0.0110 | 0.0103 |

*Green cells are below WorkSafe and SEPP limits*

Table 6. Summary of modelled maximum GLC from particulate emissions

## Discussion

The criteria for on- and off-site compliance are shown in the above table.

Comparison of the modelled maximum ground level concentration with the Worksafe 8-hour time weighted average shows that there is site-wide compliance with Worksafe exposure standards.

In general, the SEPP criteria are set at 1/30$^{th}$ of the Worksafe 8-hour time weighted average, with the exception of arsenic, chromium$^{VI}$, cadmium and beryllium which are set at 1/300$^{th}$. For all of these elements with the exception of arsenic, there is site-wide compliance with SEPP exposure standards.

| Element | Worksafe | SEPP | Test #1 | Test #2 | Test #3 | Test #4 |
|---|---|---|---|---|---|---|
| *Modelled GLC at 200m radius (μg/m³)* | | | | | | |
| Aluminium | 1000 | 33,3 | 0.0072 | 0.0313 | 0.0745 | 0.0360 |
| Antimony | 500 | 16.7 | 0.0011 | 0.0027 | 0.0006 | 0.0009 |
| Arsenic | 50 | 0.17 | 0.0010 | 0.1698 | 0.0062 | 0.0009 |
| Barium | 500 | 17 | 0.0016 | 0.0012 | 0.0017 | 0.0020 |
| Beryllium | 2 | 0.007 | 0.0002 | 0.0002 | 0.0002 | 0.0003 |
| Boron | 10000 | 333.3 | 0.0061 | 0.0056 | 0.0197 | 0.0114 |
| Cadmium | 10 | 0.033 | 0.0001 | 0.0002 | 0.0002 | 0.0007 |
| Calcium | 2000 | 66.7 | 0.1744 | 0.1452 | 0.3106 | 0.1648 |
| Chromium$^{VI}$ | 50 | 0.17 | 0.0006 | 0.0019 | 0.0006 | 0.0002 |
| Cobalt | 50 | 1.7 | 0.0002 | 0.0001 | 0.0001 | 0.0002 |
| Copper | 200 | 33 | 0.0020 | 0.0025 | 0.0009 | 0.0007 |
| Iron | 5000 | 166.7 | 0.0031 | 0.0219 | 0.0435 | 0.0213 |
| Lead | 150 | 5.0 | 0.0122 | 0.0380 | 0.0205 | 0.0390 |
| Lithium | 25 | 0.8 | 0.0002 | 0.0002 | 0.0001 | 0.0002 |
| Magnesium | 10000 | 333.3 | 0.1308 | 0.0894 | 0.0828 | 0.1199 |
| Manganese | 1000 | 33.3 | 0.0028 | 0.0029 | 0.0043 | 0.0042 |
| Mercury | 25 | 0.8 | 0.0002 | 0.0002 | 0.0001 | 0.0002 |
| Molybdenum | 5000 | 166.7 | 0.0002 | 0.0002 | 0.0002 | 0.0003 |
| Nickel | 100 | 3.3 | 0.0002 | 0.0002 | 0.0003 | 0.0003 |
| Phosphorus | 1000 | 33.3 | 0.0262 | 0.0076 | 0.0203 | 0.0108 |
| Potassium | 2000 | 66.7 | 0.9808 | 0.1966 | 0.3313 | 0.7492 |
| Selenium | 100 | 3.3 | 0.0011 | 0.0007 | 0.0006 | 0.0009 |
| Silver | 10 | 0.33 | 0.0002 | 0.0001 | 0.0001 | 0.0002 |
| Sodium | 2000 | 66.7 | 0.1962 | 0.1631 | 0.2278 | 0.9889 |
| Tin | 2000 | 66.7 | 0.0004 | 0.0013 | 0.0008 | 0.0009 |
| Vanadium | 50 | 1.7 | 0.0002 | 0.0002 | 0.0002 | 0.0003 |
| Zinc | 5000 | 170 | 0.0262 | 0.3351 | 0.1532 | 0.2397 |
| Titanium | 10000 | 333.3 | 0.0002 | 0.0010 | 0.0025 | 0.0023 |

*Green cells are below WorkSafe and SEPP limits*

Table 7. Summary of modelled GLC at 200m radius from particulate emissions

**Discussion**

At a distance of 200 metres from the source, all of these elements including arsenic, shows site-wide compliance with SEPP exposure standards.

## Organics analysis

| Substance |
|---|
| Ethanol |
| Isopropanol |
| 1,1-Dichloroethene |
| Dichloromethane |
| trans-1,2-Dichloroethene |
| cis-1,2-Dichloroethene |
| Chloroform |
| 1,1,1-Trichloroethane |
| 1,2-Dichloroethane |
| Benzene |
| Carbon tetrachloride |
| Butanol |
| 1-Methoxy-2-propanol |
| Trichloroethene |
| Toluene |
| 1,1,2-trichloroethane |
| Tetrachloroethene |
| Chlorobenzene |
| Ethylbenzene |
| m + p-Xylene |
| Styrene |
| o-Xylene |
| 2-Butoxyethanol |
| 1,1,2,2-Tetrachloroethane |
| Isopropylbenzene |
| Propylbenzene |
| 1,3,5-trimethylbenzene |
| tert-Butylbenzene |
| 1,2,4-trimethylbenzene |
| 1,2,3-trimethylbenzene |
| Acetone |
| Pentane |
| Acrylonitrile |
| Hexane |
| Methyl ethyl ketone |
| Ethyl acetate |
| Cyclohexane |
| 2-Methylhexane |
| 2,3-Dimethylpentane |
| Isopropyl acetate |
| 3-Methylhexane |
| Ethyl acrylate |
| Heptane |
| Methyl methacrylate |
| Propyl acetate |
| Methylcyclohexane |
| MIBK |
| 2-Hexanone |
| Octane |
| Butyl acetate |
| 1-methoxy-2-propyl acetate |
| Butyl acrylate |
| Nonane |
| Cellosolve acetate |
| alpha-Pinene |
| beta-Pinene |
| Decane |
| 3-Carene |
| D-Limonene |
| Undecane |
| Dodecane |
| Tridecane |
| Tetradecane |
| Residuals as Toluene |

Table 8. List of organics analysed

| Test | Organic components | | | |
|---|---|---|---|---|
| | Residuals as Toluene | Benzene | Toluene | Total vs n-hexane |
| *Concentrations - mg/Nm³* | | | | |
| Clean wood waste | 0.65 | 12 | 0.48 | 14 |
| Mixed industrial wood waste | 0.37 | 0.3 | 0.32 | 0.49 |
| Clean particle board/plywood | 1.2 | 0.93 | 0.53 | 2.3 |
| Laminated waste | 0.70 | 1.1 | 0.65 | 1.6 |
| *Mass Rates - g/min* | | | | |
| Clean wood waste | 0.156 | 2.880 | 0.115 | 3.360 |
| Mixed industrial wood waste | 0.091 | 0.074 | 0.079 | 0.121 |
| Clean particle board/plywood | 0.274 | 0.212 | 0.121 | 0.524 |
| Laminated waste | 0.231 | 0.363 | 0.215 | 0.528 |

*figures in red represent "less than limits of detection"*

Table 9. Summary of organic emissions

**Discussion**

From the list of organics in table 5, all substances were below the detectable limit (0.4 mg/m³), with the exception of benzene (from clean wood 12.45 mg/m³) and toluene (from clean particle board 1.2 mg/m³).

By applying the Aermod modelling process as used for heavy metal emissions, the maximum GLC caused by the emission of benzene is 0.1923 µg/m³ and toluene is 0.0184 µg/m³ neither of these will cause any exceedance of Worksafe (Benzene 3200 µg/m³, Toluene 191,000 µg/m³) or SEPP (Benzene 53 µg/m³, Toluene 650µg/m³) standards.

## Odour

| Test | odour |
|---|---|
| *Concentrations - odour units (ou)* | |
| 1. Clean wood | 360 |
| 2. Painted wood | 770 |
| 3. Particle board | 1100 |
| 4. Laminates | - |
| *Emission rates - ouv/min* | |
| 1. Clean wood | 90,720 |
| 2. Painted wood | 194,040 |
| 3. Particle board | 264,000 |
| 4. Laminates | - |

Table 10. Summary of odour emissions

**Discussion**

By applying the Aermod modelling process as above, the maximum GLC caused by the emission of the highest odour (264,000 ouv/min from test #3) is 0.46ou. No appreciable odour should be detected either on or off site.

## Ash analysis

| Test | Ash residual metals | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aluminium | Antimony | Arsenic | Barium | Beryllium | Boron | Cadmium | Calcium | Chromium | Cobalt | Copper | Iron | Lead | Lithium | Magnesium | Manganese | Mercury | Molybdenum | Nickel | Phosphorus | Potassium | Selenium | Silver | Sodium | Tin | Titanium | Vanadium | Zinc |
| *Concentrations - mg/kg* | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Clean wood waste | 10000 | 7 | 4 | 94 | 1 | 16 | 0.4 | 9000 | 10 | 4 | 6 | 9300 | 9 | 1 | 2800 | 410 | 0.1 | 1 | 4 | 1600 | 3100 | 2 | 1 | 580 | 1 | 68 | 21 | 13 |
| Mixed industrial wood waste | 12000 | 7 | 2200 | 120 | 1 | 130 | 0.4 | 70000 | 1400 | 7 | 2100 | 7600 | 150 | 5 | 7200 | 740 | 0.1 | 1 | 7 | 2200 | 9800 | 2 | 1 | 13000 | 4 | 370 | 15 | 490 |
| Clean particle board/plywood | 13000 | 7 | 10 | 87 | 1 | 120 | 0.4 | 34000 | 13 | 3 | 17 | 7900 | 5 | 2 | 3500 | 420 | 0.1 | 1 | 5 | 1500 | 6900 | 2 | 1 | 7200 | 4 | 310 | 19 | 81 |
| Laminated waste | 8700 | 7 | 4 | 160 | 1 | 45 | 0.4 | 35000 | 10 | 7 | 7 | 6400 | 9 | 2 | 2100 | 280 | 0.1 | 1 | 4 | 580 | 5100 | 2 | 1 | 5600 | 1 | 420 | 16 | 130 |

*figures in red represent "less than limits of detection"*

Table 11. Metal content of ash samples

### Discussion

The ash from three of the tests (#1, #3 and #4) contain no appreciable "heavy metals" or other elements of concern. However, the ash from the mixed treated timber (test #2) contained high concentrations of arsenic, chromium and copper, with lesser concentrations of lead and zinc.

Ash from this mixture would not be suitable for composting or similar avenues of disposal. It is reasonably easy to reduce the potential of treated timber remaining in the waste to be processed with the use of an XRF analyser for screening arsenic, chromium, copper (CCA) and other wood treatments, as e.g. available from Olympus. This laser type device accurately identifies CCA components.

These analysers come in both handheld and permanently mounted configurations and are readily available for purchase or hire. With these units both the incoming raw wood waste stream and the residual ash can be tested for CCA and verified in seconds.

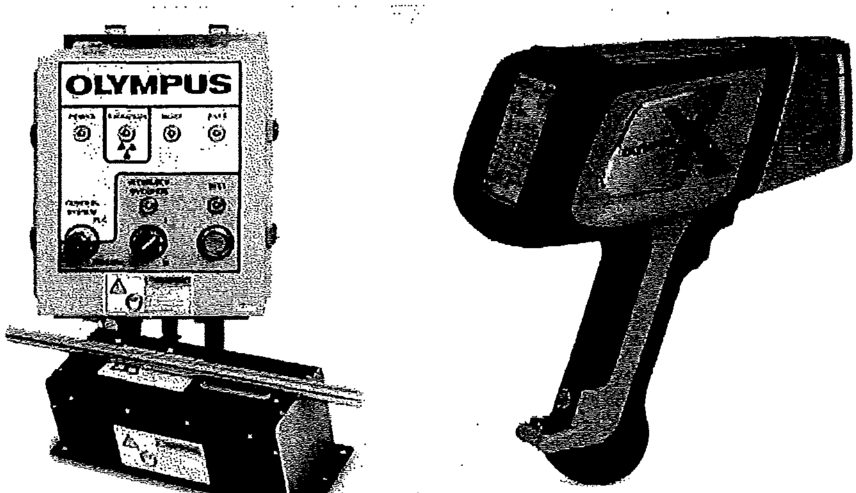


Figure 12. Olympus XRF analysers – in-line and hand held.

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# Technical Summary of Energy from Waste

A submission to ACT NoWASTE

03 July 18

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# Glossary

| Terminology | Description |
|---|---|
| ARENA | Australian Renewable Energy Agency |
| C&D | Construction and Demolition (waste) |
| C&I | Commercial and Industrial (waste) |
| CEFC | Clean Energy Finance Corporation |
| DADI | Dial a Dump Industries |
| DGRs | Director General's Requirements |
| DPE | (NSW) Department of Planning and Environment |
| EfW | Energy from Waste (a.k.a. WtE) |
| EfW Guideline | (Victoria) Energy from Waste Guideline |
| EIS | Environmental Impact Statement |
| EPA | Environment Protection Authority |
| EPL | Environmental Protection Licence |
| EU | European Union |
| GHG | Greenhouse Gas |
| HCl | Hydrogen chloride |
| MRF | Materials Recovery Facility |
| MSW | Municipal Solid Waste |
| $NH_3$ | Ammonia |
| $Nm^3$ | Normal cubic metre (measured at 0°C and 1 atmosphere pressure) |
| NSW EfW Policy | NSW EfW Policy Statement |
| POEO | Protection of the Environment and Operations Act |
| RDF | Refuse Derived Fuel |
| ROCs | Regional Organisations of Councils |
| SEARs | Secretary's Environmental Assessment Requirements |
| $SO_2$ | Sulphur dioxide |
| SRF | Solid Refuse Fuel (a.k.a. PEF) |
| TEQ | Toxic equivalency |
| the EfW Policy | The NSW Energy from Waste Policy Statement |
| TNG | The Next Generation |
| WtE | Waste to Energy (a.k.a. EfW) |

# Contents

# List of Tables

# List of Figures

# 1 Introduction

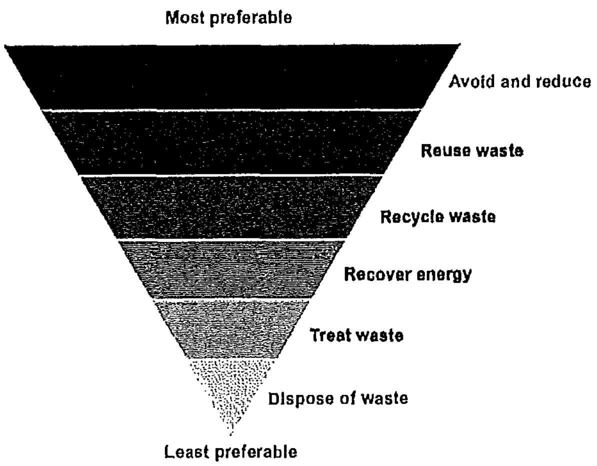
ACT NoWaste is developing an Energy from Waste (EfW) policy for the Australian Capital Territory (ACT). This paper outlines the current state of EfW in terms of technology options and their strengths and weaknesses as well as how key projects have developed and are performing domestically and abroad. The applicability of EfW in an ACT context, current waste management status and government priorities are also reviewed.

## 1.1 Energy from waste as a method of solid waste management

Internationally, management of solid waste is guided by a Waste Management Hierarchy stipulating the preferred order of approaches for dealing with these materials. Under the hierarchy, usually depicted as an inverted pyramid (Figure 1), waste avoidance is the most preferred approach. If waste avoidance or reduction is not possible, then subsequent approaches – in order of decreasing preference – are reuse of waste items, recycling of the materials in the waste items, recovery of the energy embodied in the waste (through EfW processes), treatment, and finally disposal to landfill.

These methods are meant to be employed sequentially with preference always given to higher order ones. Therefore, EfW should only be considered for residual waste (waste that is left over following material recovery for reuse and recycling). In economic terms residual waste is the waste for which energy recovery represents the most feasible option, due to the absence of a market for the otherwise waste materials. This generally means the environmental or economic costs of further separating and cleaning the waste are greater than any potential benefit of doing so.

Figure 1 - Waste Management Hierarchy (source: NSW EPA)




Essentially, the waste management hierarchy indicates that there is no single solution to adequately manage waste in a sustainable, financially viable manner. It requires an integrated set of solutions working in a cohesive manner. Education and awareness, building networks, infrastructure for recycling, market development for reuse, facilities for energy recovery and treatment and finally landfills for disposal all form part of the solution.

EfW has emerged as a key piece of the waste management puzzle for two primary reasons: firstly, it allows the harvesting of energy that would otherwise remain unused in landfill and secondly it reduces the burden on landfills by reducing the quantity and volume of residual waste for disposal.

While recycling is a key element of the overall solution, technical and market restrictions mean there is a practical ceiling to the amount of materials that can be recycled or recovered from waste. Residual waste will always be present and EfW can minimise it. Additionally, EfW provides an opportunity to support additional recycling of metals and other material from residual waste through recovery from bottom ash (that would otherwise be lost to the economy through landfilling).

# 2 Scope

The scope of this review is as follows:

a) A summary of all available EfW technologies and processes for managing solid waste, including a brief analysis of how long these technologies have been around (are they well-established or novel) and the kind of feedstocks they can accept;

b) A breakdown of what is classified as thermal, cool and/or other methods and how these are distinguished from each other;

   With the above in mind, a high-level summary of the processes that could potentially be undertaken in the ACT without burning or using heat within the ACT. This is not intended to be a highly detailed or technical analysis;

c) A high-level analysis of the likely viability (including where the ACT does not need to import waste) and market interest for each of these technologies in an ACT context with consideration to waste generation volumes, including biochar production through pyrolysis. This does not include a full financial analysis or cost-benefit analysis of all options and is intended to be high level only;

d) A case study of each of these technologies where they have been applied in Australia, or if this is not available, overseas;

e) A high-level analysis of the benefits and problems associated with each technology, with the ACT context in mind and a focus on whether each technology has been accepted in communities, any associated health/environmental impacts or concerns and general separation distances from residential areas. This should also include if there have been no adverse health or environmental impacts/findings from these technologies;

f) A high-level summary of how air quality, emissions and environmental impacts are generally managed and mitigated for each technology and whether these methods are proven. This is not intended to be a fully detailed analysis, noting that impacts depend on a number of factors down to the individual project level; and

g) Where known and available, a high-level overview of the different community/stakeholder engagement approaches and reactions to these for major EfW projects across jurisdictions in recent years. The intent of these is to understand what kind of engagement approaches are most successful with the community when it comes to EfW to inform the ACT Government's proposed community engagement approach.

# 3 EfW technologies and processes

## 3.1 Type of technology

*Thermal* and the *non-thermal* process routes are the two broad approaches for the recovery of embodied energy (or energy which can be recovered) from waste. A thermal process involves heat and is generally characterised as "burning", while a non-thermal approach involves the recovery of energy through biological methods. Within each there are a variety of technical options available on the market, each representing a proprietary process offered by their respective designers and suppliers. Each system will have its own benefits and is therefore not necessarily suited for all projects and users. The important consideration is to ensure that the process operation and emissions conform to best practice.

### 3.1.1 Thermal

Thermal technologies which are applied to recover energy from waste are not new. While they have been refined through modern innovations, the basic concepts have been in operation for many years. Most were originally applied to wood in order to create heat or intermediate fuel products; upgraded variants of these early technologies have been adapted manage waste and recover their embodied energy.

Energy recovery from non-recyclable and non-reusable waste through thermal treatment is an alternative to landfill that is well established overseas. The process significantly reduces the volume and mass of waste and can also render some types of hazardous waste inert. The principal product is heat which is either used to generate electricity or applied directly for process or district heating. Specialised filters are used to control and minimise process emissions to air and water.

Thermal processes fall into three types: incineration, gasification and pyrolysis.

Ferrous (containing iron) and non- ferrous (other metals such as copper or aluminium) metals can be recovered either before thermal treatment (using a front-end materials recovery facility (MRF)) or after thermal treatment from ash residues. Bottom ash and slag, or by-products, from the process can be recovered and (subject to local regulations) used to manufacture building materials. However, the ash is often landfilled because of concerns about heavy metal contamination levels or because recovery is not financially viable. Typically, 5% to 25%[1] of the mass of waste processed through EfW is sent for landfill disposal, thereby significantly conserving landfill void space as well as reducing the odour issues often associated with landfilling.

Gasification and Pyrolysis technologies require a uniform consistent feedstock stream that, for mixed residual Municipal Solid Waste (MSW), necessitates some form of pre-processing or sorting to remove unsuitable materials and ensure consistency.

While there are currently no thermal facilities operating in Australia processing municipal solid waste (MSW), Commercial and Industrial (C&I) or Construction and Demolition (C&D) waste, there are numerous facilities that have been operating overseas for many decades. EfW is principally implemented in four regions (ISWA, 2013):

1. Europe - mainly Germany, Scandinavian Countries (Norway, Sweden, Denmark), France, Netherlands, Italy, United Kingdom (around 500 installations);

[1] Ash generation is dependent on the feedstock being used. The Phoenix facility in WA expects that generated ash will be a maximum of 5% of the incoming waste. However, in Europe 230-280 kg of ash per input tonne is not uncommon (ISWA, 2006) due to a higher proportion of recyclables being removed from the waste before it is burnt.

2. United States (71 installations as at the end of 2015 burning approximately 30 million tpa);
3. Japan (more than 1,000 installations); and
4. China and South Korea (around 120 installations, growing fast).

The boundary conditions for EfW are quite different in these regions, therefore, what is successful and feasible in one region may not be feasible in another region. Gate fees are also dependent upon local conditions including environmental regulations, local legislation and gate fees for other waste management options such as landfill.

Drivers for the construction of EfW plants include a high landfill cost, a lack of space for landfilling, and a regulatory obligation to switch to renewable energy sources.

In Australia, these drivers are not widely present. The Sydney Metropolitan region in NSW is possibly the only region in Australia which has policies regarding all three drivers. Without these baseline requirements or a major policy push, it is unlikely that an EfW facility will prove to be economically successful.

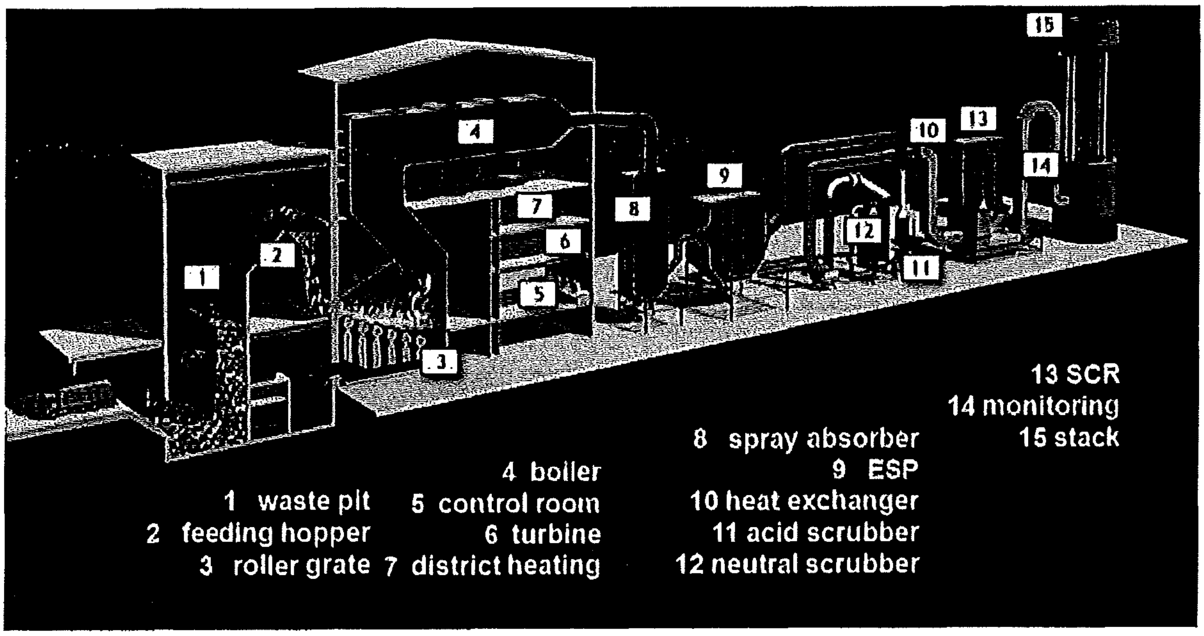
#### 3.1.1.1 Incineration (Combustion)

Incineration dominates in Europe. Process residuals (ash and residuals from flue gas cleaning) are disposed of at controlled sites such as a landfill or disused mines. Gases generated are cleaned to remove particulate matter, acid gases and other contaminants such as dioxins and furans.

In combustion processes, the waste feedstock undergoes complete oxidation in a furnace releasing heat into the gaseous and solid combustion products. Energy recovery is achieved by using the hot combustion gases to create steam, which is then expanded through a steam turbine to generate electricity.

A process flow diagram for a typical incineration plant is shown in Figure 2[2]

**Figure 2 - Flow diagram of a typical MSW grate incinerator equipped with a roller grate**




[2] IEA Task 36 – Overview of Technologies Used for Energy Recovery

As incineration occurs in combustion chambers, ash is left as a residue at the bottom of the chamber. This ash consists of sintered combustion products, mineral components, metal scrap and other unburnt materials, which can either be recycled or landfilled. There is growing research into technologies that make use of this ash.

Hazardous materials are destroyed through high temperature combustion. Incineration is also used to process many kinds of harmful chemicals, such as solvents, PCBs and pesticides.

Most incinerators employ a moving grate to move the waste through the combustion chamber and allow for complete and effective combustion. Such plants are generally large scale, capable of processing over 35 tonnes per hour of waste. In order to fully breakdown toxins in the combustion products, such as dioxins, the flue gases must reach 850°C for at least 2 seconds.

The benefits and drawbacks of incineration are summarised in Table 1.

Table 1 - Incineration SWOT analysis

| Strengths | Weaknesses |
|---|---|
| • Maximum diversion of MSW from landfill<br>• Well established and effective treatment process<br>• Many international incinerators<br>• Robust technology which handles multiple heterogeneous (mixed composition and particle sizes) streams<br>• Proven, reliable technology<br>• Fixed price not impacted by market changes for commodity prices<br>• Can assist the ACT in achieving landfill diversion targets and complement existing waste management as per waste hierarchy | • EfW facility approvals complicated<br>• Significant political opposition to incineration of waste<br>• High capital cost<br>• Requires gas and residue treatment plants as well as clean-up of emissions to ensure toxics (dioxin, furans) and fly ash particulates control |
| **Opportunities** | **Threats** |
| • Move ACT towards zero waste<br>• Significant GHG emission reductions through reduced landfilling and recovered energy | • Potential public opposition to waste incineration<br>• Although the technology is accepted by local communities abroad, this has not occurred in Australia. Experience to date has been community opposition<br>• Potential failure of emissions clean up system<br>• Needs high calorific value waste to keep the combustion process going, otherwise requires a high energy input to maintain high temperatures |

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| | |
|---|---|
| | • An expensive fixed asset requiring committed inputs through long term contracts. This can act as a disincentive to recycling and resource recovery |

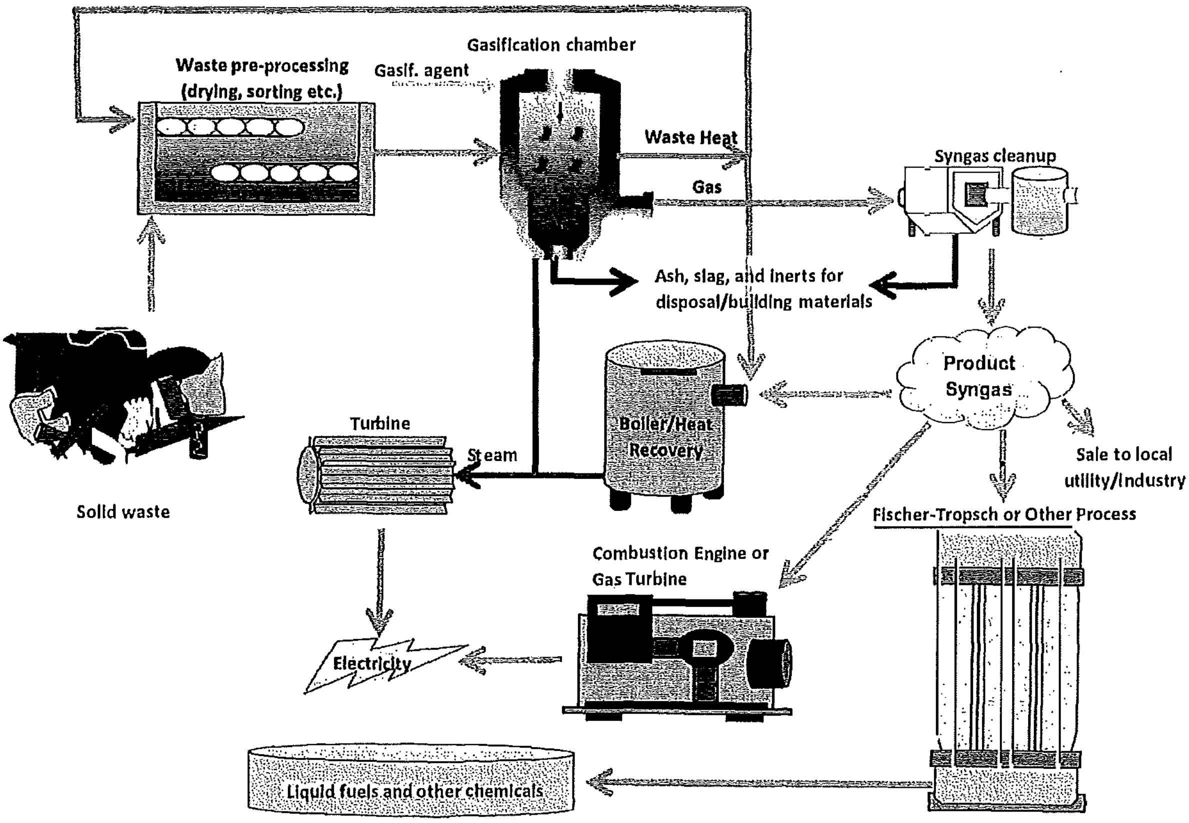
### 3.1.1.2 Gasification

Gasification is sometimes confused with combustion; however, it is a process carried out under highly controlled conditions. Gasification involves heating material at elevated temperatures in the presence of controlled quantities of air (or oxygen) or steam. The high temperature volatilises organic compounds forming various gas and tar products. The tars are cracked, and any carbon residue is oxidised. The process is *exothermic,* meaning it gives off heat, and the final products are a combustible gas, and ash (Figure 3).

Gasification with air generates *producer gas* while gasification with oxygen generates *synthesis gas.* Both are combustible, but have different concentrations of carbon monoxide, hydrogen, methane, carbon dioxide and nitrogen. Both producer and synthesis gas can be burnt in another process for the production of energy and synthesis gas can also be used for the production of chemicals such as methanol, an important industrial chemical or a liquid fuel.

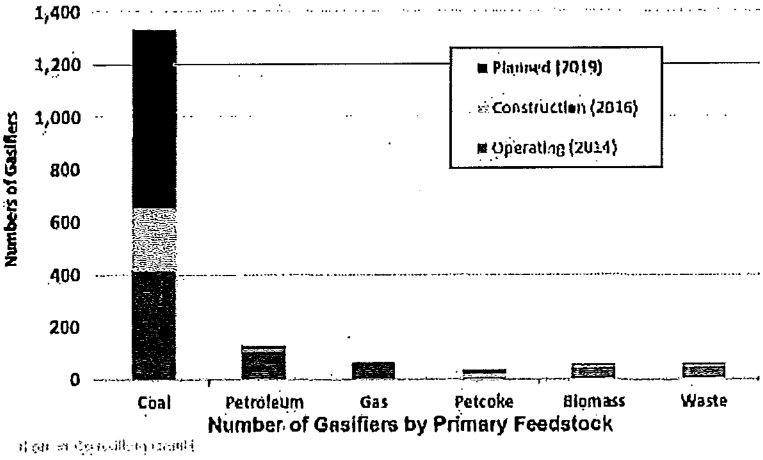
Gasification is not a new process. Fuel shortages during World War 2 resulted in many transport vehicles being fitted with rudimentary small gasifiers and being effectively powered by wood.

Figure 3 - Flow diagram of a typical MSW gasification facility *(Source: EREF, 2013)*



Internationally, gasification of MSW, as a technology, has seen more failures than successes. Some innovative gasification plants have fallen victim to poor planning, inaccurate cost predictions and unexpected technical issues. Gasification has been applied for the management of mixed urban waste, however it is not yet as widely commercially developed as combustion processes and tends to be of a smaller scale. Raw MSW is usually not appropriate for gasification and typically would require some mechanical preparation and separation of glass, metals and inert materials (such as rubble) prior to processing the remaining waste. In comparison with traditional incineration, gasification is more efficient in recovering energy. While incineration can recover approximately 550 kWh of electricity per tonne of MSW, gasification can recover approximately 1,000 kWh (depending on the feedstock composition). Overall, gasification using waste as a feedstock comprises a relatively small proportion of all gasification facilities (Figure 4).

Figure 4 - Gasification facilities by feedstock type *(Source: Higman Consulting GmbH)*




There is no clear link between plant size and success. In Finland a number of large plants have experienced success while in North America smaller plants have also proven to be sound investments. Ultimately, the success or failure of gasification projects depends on both the economic climate of the waste industry in the region as well as strategic planning for the localities, demand for products and waste disposal costs.

Gasification of waste is more common in other parts of the world and is used mainly for specific types of waste and not MSW in general. The greater concentration of gasification facilities is in the greater Tokyo region in Japan where total capacity is approximately 760,000 tpa, with its six plants ranging in capacity from 70,000 tpa to 200,000 tpa (Furusawa, no date).

A variant of conventional gasification is *Plasma Gasification* which is carried out by exposing waste to very high temperatures (4,000 – 7,000°C) generated by a plasma arc. The wastes are decomposed and produce syngas, a vitrified slag and a molten metal. The proportions and composition of the products will depend on the composition of the input materials. Emissions of pollutants such as nitrogen oxides and sulphur dioxide are effectively avoided, but other contaminants such as hydrogen sulphide, ammonia and carbonyl sulphide may have to be abated.

The benefits and drawbacks of gasification technologies are summarised in Table 2.

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Table 2 - Gasification SWOT analysis

| Strengths | Weaknesses |
|---|---|
| • Maximum diversion of MSW from landfill<br>• Limited availability of oxygen results in less combustion gases requiring treatment<br>• Generates a syngas which can be used for electricity or heat<br>• Fixed price, not impacted by market changes<br>• Can assist the ACT in achieving landfill diversion targets and complement existing waste management as per waste hierarchy<br>• Lower capital cost than incineration | • EfW facility approvals complicated<br>• No demonstrated large-scale gasifiers operating on MSW<br>• Significant political opposition to gasification of waste<br>• Expensive technology<br>• Requires gas and residue treatment plants as well as clean-up of emissions to ensure toxics (dioxin, furans) and fly ash particulates control<br>• Not a proven, reliable technology for MSW |
| **Opportunities** | **Threats** |
| • Move ACT towards zero waste<br>• Significant GHG emission reductions through reduced landfilling and recovered energy | • Potential public opposition to waste gasification<br>• Potential failure of emissions clean up system<br>• An expensive fixed asset requiring committed inputs through long term contracts. This can act as a disincentive to recycling and resource recovery |

#### 3.1.1.3 Pyrolysis

Pyrolysis is not a new process as evidenced by the fact that charcoal has been manufactured by the pyrolysis of wood for centuries. In the early 19th century the process was used to supply coal gas for urban lighting.

Pyrolysis is often confused with gasification, but it is in fact a process carried out under completely different conditions. Biomass (such as wood, agricultural residues or coal) is heated in a very low oxygen environment at temperatures above 430°C. The biomass decomposes and produces the following products:

- Char (carbon such as charcoal or coke);
- A gas with a high calorific value. Its composition varies, but in general it is made up largely of hydrogen and methane with small amounts of other hydrocarbons, carbon monoxide, carbon dioxide, and nitrogen; and
- Oils and tars.

The char and the gas can be used as fuels in other processes. The oils and tars can be a problem, but they are also a source of a wide range of organic compounds.

Pyrolysis gas can be burned in a boiler or in an engine for the direct production of electricity. In this case, care must be taken to clean the gas and remove all tars and particulates.

The process is *endothermic* meaning it requires heat to be supplied, generally through burning some of the combustible gases produced. Pyrolysis will remove and destroy the volatile components of the biomass. The residual carbon is unaffected because there is insufficient oxygen for it to react further and oxidise.

Pyrolysis has not been successfully used to treat mixed municipal wastes and would in all likelihood be unsuitable for this application because the heterogeneous nature of the waste would result in high contamination of the product char, rendering it unsuitable for most applications.

Table 3 - Pyrolysis SWOT analysis

| Strengths | Weaknesses |
|---|---|
| • Moderate diversion of MSW from landfill<br>• Several international pyrolysis plants operating on clean organics<br>• Similar to incineration but eliminates oxygen – therefore generates fewer emission gases<br>• Generates a biochar and syngas<br>• Syngas can be used for electricity or heat<br>• Biochar likely to be an attractive method of sequestering carbon in soil – likely to attract government funding<br>• Can assist the ACT in achieving landfill diversion targets and complement existing waste management as per waste hierarchy | • EfW facility approvals complicated<br>• MSW is too heterogeneous for pyrolysis<br>  o No pyrolysis plants operating on MSW<br>  o Pre-treatment of MSW necessary or risk having inefficient process<br>• Significant political opposition to pyrolysis of waste<br>• Expensive technology<br>• Requires gas and residue treatment |
| **Opportunities** | **Threats** |
| • Move ACT towards zero waste<br>• Significant GHG emission reductions through reduced landfilling and recovered energy | • Potential opposition to waste pyrolysis<br>• Potential failure of emissions clean up system<br>• Needs organic waste stream inputs. No plants operating on MSW |

#### 3.1.1.4 Refuse Derived Fuel

The pre-treatment of residual waste prior to combustion to produce a specific fuel fraction is increasing globally. Fuel produced from combustible waste is referred to as *Refuse Derived Fuel* (RDF). RDF consists of the combustible components of the residual waste stream: non-recyclable plastics (PVC is generally removed), residual organics, paper cardboard, labels, and other corrugated materials. This waste is separated by different processing steps that may include screening, air classification, ballistic separation, separation of ferrous and non-ferrous materials, glass, stones and other foreign materials and shredding into a uniform grain size, in order to produce a homogeneous material which can be used as substitute for fossil fuels.

Often the production process will aim to produce a fuel product which meets a stringent specification, in which case the product is referred to as *Solid Recovered Fuel* (SRF) or *Process Engineered Fuel* (PEF). These latter terms are used interchangeably, and these materials generally have greater market acceptance because of the greater reliability they offer for a downstream thermal process as a result of their relative homogeneity. RDF is a by-product from the processing of waste while PEF/SRF has specifications for its quality and composition.

PEF/SRF is defined in Europe as a solid fuel prepared from non-hazardous waste to be utilised for energy recovery and meeting the classification and specification requirements set out in EN15359. In general, PEF/SRF has a higher calorific value and lower moisture content than RDF, making it a more attractive fuel.

This approach enables the recovery of energy to occur at a different site to that where the waste is processed, thereby reducing the dis-amenity associated with transporting large quantities of waste materials and enabling this type of fuel to be traded as a commodity. The fuel can take various forms depending on the type of energy recovery system to be used. This includes a loose or flock material, which has been size-reduced, or extrusions into a fuel pellet.

MSW has a low calorific value (CV) and therefore it is not a dense fuel source for energy generation. As such, and in addition to the various restrictions around waste transport and combustion, it is not suitable for use as a fuel outside of the specially built facilities outlined in section 3.1.1. For raw mixed MSW to become a high-quality fuel, it is necessary to process to improve its consistency (in terms of size), storage and CV. The product is often pelletised and then sold as fuel to cement kilns and power stations. The pre-treatment of residual waste prior to combustion to produce a specific fuel fraction is increasing globally.

Pelletisation involves the processes of segregating, crushing, mixing high and low CV organic waste material and solidifying it to produce fuel pellets. The process condenses the waste and enriches its organic content through removal of inorganic materials and moisture. The calorific value of RDF pellets can be up to 16 GJ/t while the calorific value of raw MSW is typically 8 – 12 GJ/t (it varies by region).

Since modifying existing power plants to use PEF can be challenging (but not prohibitive), the use of PEF in cement kilns emerges as a better solution, especially since the cement product absorbs the ash and many of the pollutants from combustion. There are only a few cement kilns operating in Australia and none in the ACT. However, there is growing demand from the many cement kilns in South East Asia where local waste characteristics and market conditions limit local PEF production.

Table 4 - RDF SWOT analysis

| Strengths | Weaknesses |
|---|---|
| • Well established, low risk technology<br>• Moderate diversion of MSW from landfill<br>• Many international facilities<br>• Proven, reliable technology<br>• Can assist the ACT in achieving landfill diversion targets and complement existing waste management as per waste hierarchy<br>• Reduced likelihood that it will be opposed by the public as it does not involve local combustion of waste | • Current domestic market outlets are limited<br>• Export markets are still in early stages of development<br>• Product specifications need to be tailored to individual users |

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| Opportunities | Threats |
| --- | --- |
| • Move ACT towards zero waste<br>• Significant GHG emission reductions through reduced landfilling and recovered energy<br>• Develop international markets | • Closure of local cement kilns<br>• Needs high calorific value waste<br>• May undermine recycling efforts (potential disincentive for pursuing further source separation opportunities for plastics and organics) |

### 3.1.2 Non-thermal

In Australia, energy recovery from solid waste through non-thermal treatments is in wide use. The main pathway for capturing energy from waste has been the installation of landfill gas capture systems in both existing and new sites. The other option, anaerobic digestion, is less widespread as it requires specialised facilities and feedstock.

#### 3.1.2.1 Landfill Gas Capture

Traditionally Australia has relied on landfill as the main means of waste disposal. Over time, anaerobic conditions (oxygen free) prevail within landfills. The waste organic fraction in waste is decomposed, leading to production of landfill gas (LFG), which contains a high percentage of methane (about 50%). This gas can be collected by inserting, vertically or horizontally, perforated pipes into landfill cells. Following collection, the gas is transferred to a purification system to remove hydrogen sulphide. After cleaning, the gas can be used as a source of energy, either for direct heating/cooking applications or to generate power through internal combustion engines or turbines.

The anaerobic breakdown of organic materials involves three biological steps, each involving a well-defined class of bacteria:

- Decomposition (hydrolysis) or plant or animal matter. This breaks down organic material to usable-sized molecules such as sugar;
- Conversion of decomposed matter to organic acids; and
- Conversion of the organic acids to methane and carbon dioxide.

A key benefit of this method is that LFG extraction systems can be installed on both new and existing landfills and therefore allow the recovery of energy that would otherwise be lost within the buried waste. In addition, by reducing the release of methane to the atmosphere, LFG capture significantly contributes to climate change mitigation. A key driver behind the increasing installation of LFG systems in landfills in Australia and around the world has been the provision of incentives for the management of greenhouse gas emissions.

ACT already captures gas for energy recovery at the Mugga Lane landfill. Landfills continue to generate LFG, and therefore energy, for many years after closure as decomposing putrescible waste continues to produce methane. Therefore, EfW from landfill gas capture will continue around Australia and in the ACT for some time. In the long term however, LFG capture is less appealing as an energy source compared to alternatives due to its limited efficiency (and the loss of other resources such as metals). It is estimated that over the life of a landfill only about 50% of the LFG is captured and the energy content of non-putrescible material is not recovered.

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The *Bioreactor Landfill* is a relatively recent landfill design approach which aims to address part of the inefficiency. By being designed from the outset with the aim of maximising gas capture, operators claim that well managed bioreactor landfills can capture upwards of 70% of the gas generated. Although this claim is often contested in the industry, the consensus is that they are more effective than traditional designs in both capturing LFG and speeding up the decomposition of putrescible organic waste.

Despite their advantages, bioreactors are still landfills and therefore low in the waste management hierarchy. Landfilled resources are still mostly lost to the economy and the strategic direction of modern waste management industry is to focus on resource recovery.

**Table 5 - Landfill Gas SWOT analysis**

| Strengths | Weaknesses |
|---|---|
| • Well established, low risk technology<br>• Relatively cheap technology<br>• Abundant operational expertise<br>• No pre-treatment of waste necessary | • Significant loss of resources<br>• Does not assist ACT in achieving landfill diversion targets<br>• Political and community opposition to landfill<br>• Landfill approvals getting harder |
| **Opportunities** | **Threats** |
| • Moderate GHG emission reductions with an efficient LFG capture system<br>• Re-use of mining sites<br>• Increased diversion by removing recyclables and organics from waste prior to landfilling, reduces the potential for gas generation | • Potential failure of emissions capture and leachate management systems<br>• Needs long term management and therefore a sufficient proportion of income needs to be hypothecated for long term (up to 50 years) monitoring and rehabilitation |

### 3.1.2.2 Anaerobic Digestion

In Anaerobic Digestion, the biological processes which occur naturally in a landfill environment are undertaken in an engineered in-vessel system. As in landfills, the breakdown of organic material results in the production of biogas, a mixture of methane and carbon dioxide. The biogas can be used as an alternative source of energy, essentially as a replacement of natural gas. A by-product of AD is "*digestate*", which remains after the gas generation potential is exhausted. This is a nutrient rich slurry which can be further processed to produce compost or soil conditioner.

AD is best suited for processing source separated wet organic materials (such as residual food wastes or sewage sludge), otherwise the residual digestate is likely to be too contaminated to allow further use.

There are only a handful of AD facilities currently operating in Australia. In general, mixed waste processing through AD in Australia has not performed well. Facilities have suffered mechanical, operational or financial problems in their start up or ongoing operations. For example, the ArrowBio facility in Jacks Gully, originally established by UK company, ArrowBio Ecology, suffered significant operational and financial issues associated with high levels of contaminants in the waste feedstock. The AD component of the Eastern Creek UR-3R AWT facility was eventually decommissioned as it could not successfully process MSW feedstock.

For source separated organic materials however, AD does however provide a low risk route to capture energy from waste without relying on thermal treatment. For that reason, it is being pursued by both government agencies such as water authorities and some local councils.

Table 6 - Anaerobic digestion SWOT analysis

| Strengths | Weaknesses |
| --- | --- |
| • Well established technology<br>• Generation of heat/electricity provides a potential revenue stream<br>• Existing market for digestate<br>• Possible reduction in costs relative to landfilling<br>• Lower risk EfW compared to thermal treatments | • No demonstrated success in Australia with MSW feedstock. A number of facilities have failed in the past due to operational and financial issues<br>• High cost initial costs (estimated at over $700 per annual tonne of capacity)<br>• A large amount of start-up equipment is required including, feedstock pre-processing equipment, storage, digester, energy generator and hydrogen sulphide management<br>• Technology not proven for treatment of garden waste mixed with food. The woody lignocelluloses need to be extracted from the waste prior to digestion. This adds cost and reduces diversion<br>• The digestate requires stabilisation before it can be commercially applied<br>• Contamination of over 5% leads to operational problems<br>• Depends on community participation and acceptance of the third bin to achieve good source separation |
| **Opportunities** | **Threats** |
| • Move ACT towards zero waste<br>• Significant GHG emission reductions through reduced landfilling and recovered energy<br>• The digestate produced can be processed further and sold as a high-quality compost product - can be certified to Australian Standards | • Operational costs can vary widely ($50 to $200 per tonne of waste processed)<br>• Requires clean waste stream |

## 3.2 Technology summary

Table 7 summarises key aspects of the major EfW technologies described above.

To prevent harm to human health and the environment, all waste management facilities in Australia are regulated through legislation, development approvals, and environmental and operational licenses. Monitoring of facilities is undertaken by a number of agencies in each state, including the respective EPAs, with some projects also being overseen by the local council where they are located.

Table 7 - Summary of major EfW technologies

| | Incineration | Gasification | Pyrolysis | Landfill | RDF | AD |
|---|---|---|---|---|---|---|
| Historical use | Burning of waste is a very old practice. The first known waste incinerator was built the UK in 1874. In the early 20th century, some apartment buildings had incinerators in the basements. | Experimental wood and coal gasification in late 17th century ultimately led to the use of producer gas. Waste gasification experimentation began in the 1920's and in the 1970's experimental plants were built in Europe. These facilities performed well with homogenous input but scaling up with MSW feed has not been successful. | Charcoal has been produced by pyrolysis of wood for centuries. Experimentation with pyrolysis of waste begun in the early 1970's. Scaling up with MSW has not been successful. | During the 1800's the connection between disease and waste was discovered and centralised open dumps became common. The precursor to the modern landfill is thought to have originated around 1935 in California. | First used in England at the end of 19th century with hand-picked, energy rich MSW residuals. In the 1950's waste tyres were used. In the 1980's MSW derived RDF started becoming common and its use has grown significantly since then, particularly as fuel for cement kilns. | Anecdotal evidence indicates that biogas was used for heating bath water in Assyria during the 10th century BC and in Persia during the 16th century. First AD plant was in India circa 1860. First AD to use MSW operated in US between 1939-1974. Although some MSW AD facilities operate worldwide, Australian attempts have been unsuccessful. |
| Track record processing mixed waste | Common and proven around the world but not in Australia for mixed waste. Small plants for single-stream biomass wastes. | Reference facilities but limited commercial applications processing mixed waste. A facility in Wollongong, NSW never achieved full operation and has since been decommissioned. | Mixed wet waste pyrolysis challenging and not proven. Pyrolysis of tyres in Australia appears to be promising. | Well established and proven in Australia and worldwide. | Common and proven around the world. A few facilities in Australia. | Well established and proven worldwide, especially for treating sludge. Few, small wet AD facilities in Australia. |
| Burning of waste | Yes | No, converts feedstock into through a chemical reaction to a gas which is burnt either locally or remotely. | No, converts part of the feedstock into through a chemical reaction to a gas which is burnt either locally or remotely. | No | Not during production but the RDF is eventually burnt e.g. in cement kilns. | No |

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| | Incineration | Gasification | Pyrolysis | Landfill | RDF | AD |
|---|---|---|---|---|---|---|
| Waste materials | Mixed residual waste, RDF, waste timber, agricultural residues. | Mixed residual waste, RDF, waste timber, agricultural residues. | Tyres, plastics, dry biomass, RDF | All. | High calorific residual materials derived from mixed waste, waste timber, tyres, plastics, fibres, agricultural residues. | Putrescible organics, manures, food processing waste, biosolids (sewage sludge from municipal wastewater treatment plants), abattoir wastes. |
| Typical Capacity (tpa) | 50,000 to 1 million | 50,000 to 100,000 | 10,000 to 100,000 | 3,000 to >1 million | 50,000 to >400,000 | 10,000 to 80,000 |
| Market interest | Increasing as a means of reducing landfill. | Cautionary interest. | Cautionary interest for specific materials. | Declining due to push for greater recovery. | Increasing. | Cautionary interest following setbacks related to feedstock quality. |
| Community acceptance | Accepted by local communities abroad, including by city centre communities in (for example) Vienna and Paris, in the USA, Asia and in Japan.<br>Not achieved community acceptance in Australia. | Accepted by local communities abroad.<br>In Australia it is perceived to be incineration and has not achieved the same level of community acceptance. | Accepted by local communities abroad.<br>In Australia it is perceived to be incineration and has not achieved the same level of community acceptance. | Largely accepted by local communities abroad and in Australia however there is a degree of *not-in-my-backyard* opposition. | Largely accepted by local communities abroad and in Australia however there is a degree of not-in-my-back-yard opposition. | Largely accepted by local communities abroad and in Australia however there is a degree of *not-in-my-backyard* opposition. |
| Environmental controls needed | Bottom ash, fly ash, air pollution control residues. | Bottom ash, air pollution control residues. | Air pollution control residues. | Leachate, litter and odour management. | Solid non-combustible residues. | Liquid residues, wastewater, inert & non-compostable material, contaminants. |

| | Incineration | Gasification | Pyrolysis | Landfill | RDF | AD |
|---|---|---|---|---|---|---|
| Emissions controls | In Europe, incinerators operate within city limits and are heavily regulated. Plants utilise filters (scrubbers and condensers) to remove regulated substances. Emission limits are strict and regularly monitored. No significant issues are reported.<br>As an example, a French study[‡] found that all incinerators operated with dioxin/furan emissions well below the EU and French standard of 0.1ng TEQ/$Nm^3$[§] and that total emissions decreased from 435g TEQ in 1997 to only 1.2g in 2008.<br>Australian states are looking to adopt EU's | Gasification plant emissions are controlled similarly to those in incineration facilities with scrubbers and condensers.<br>Due to the lower temperatures involved and the limited oxygen, emission levels are much lower. Dioxin emissions at the stack are generally lower than 0.01ng TEQ/$Nm^3$<br>Australian states are looking to adopt EU's stringent emission limits.<br>GHG emissions are much lower than if the same waste was landfilled. | Pyrolysis plant emissions are controlled similarly to those in incineration facilities.<br>Emissions from pyrolysis plants can also include HCl, $SO_2$, and $NH_3$ from the gaseous phase however with the appropriate equipment final emissions are well below the limits[**].<br>Australian states are looking to adopt EU's stringent emission limits.<br>GHG emissions are much lower than if the same waste was landfilled. | LFG capture systems in modern landfills capture about 50% of GHG emissions (for flaring or energy generation). | At the place of use, similar emissions controls to those for incineration are required. | Odour management via filters |

[‡] Dioxin emissions from municipal solid waste incinerators (MSWIs) in France https://doi.org/10.1016/j.wasman.2012.06.016

[§] Toxic Equivalent (TEQ) nanograms per standard cubic meter

[**] Chen, D., et al. Pyrolysis technologies for municipal solid waste: A review. Waste Management (2014), http://dx.doi.org/10.1016/j.wasman.2014.08.004

| | Incineration | Gasification | Pyrolysis | Landfill | RDF | AD |
|---|---|---|---|---|---|---|
| | stringent emission limits.<br>GHG emissions are much lower than if the same waste was landfilled. | | | | | |
| Health implications of thermal processing. | Modern incinerators meet the restrictive EU emissions standards (Industrial Emissions Directive 2010/75/EU).<br>There have been no cases reported of acute health issues as a result of any EfW facilities. Given modern pollution controls, emissions limits and enforcement by the relevant EPAs, long term health effects are also negligible and usually lower than the effects of car pollution or other industry. For comparison, EU emissions limits for EfW facilities are significantly lower than the equivalent limits for NSW coal power plants. In 2005, the German ministry of the Environment estimated that household chimneys and tiled stoves alone discharge approximately 20 times more dioxin into the atmosphere than the country's 66 incineration plants[††]. Confirming the accepted safety of EfW is the fact that multiple facilities are sited in the centre of multiple European cities.<br>A 2000 USA review concluded that a well-designed and properly operated EfW facility emits relatively small amounts of pollutants that have the potential to cause the largest health effects (particulate matter, lead, mercury, and dioxins and furans), contributes little to ambient concentrations, and is not expected to pose a substantial health risk. The review however recognises that workers at EfW facilities are at higher risk for adverse health effects from exposure than local residents[‡‡].<br>More recently, in 2006, a study that quantified the health risks of EfW facilities and compared it with other health risks concluded that the overall risk of dying due to EfW stack emissions in any one year was 1 in 4 million[§§]. The continued improvements in filter technology are likely to have reduced this risk even further. | | | | | |
| Outputs | Electricity<br>Heat | Electricity<br>Syngas | Liquid oil, fuels, solvents, Syngas, Char (biochar, carbon black), Metals, | Landfill gas<br>Leachate | RDF<br>PEF | Biogas<br>Electricity |

[††] German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety. Waste Incineration — A Potential Danger? Bidding Farewell to Dioxin Spouting; September 2005. http://www.seas.columbia.edu/earth/wtert/sofos/Waste_Incineration_A_Potential_Danger.pdf

[‡‡] National Research Council (US) Committee on Health Effects of Waste Incineration. Waste Incineration & Public Health. Washington (DC): National Academies Press (US); 2000. 5, Understanding Health Effects of Incineration. Available from: https://www.ncbi.nlm.nih.gov/books/NBK233619/

[§§] Richard J. Roberts, Mengfang Chen; Waste incineration—how big is the health risk? A quantitative method to allow comparison with other health risks, *Journal of Public Health*, Volume 28, Issue 3, 1 September 2006, Pages 261–266, https://doi.org/10.1093/pubmed/fdl037

| | Incineration | Gasification | Pyrolysis | Landfill | RDF | AD |
|---|---|---|---|---|---|---|
| | Bottom ash<br>Fly ash<br>Metals<br>Hazardous gas clean-up residues | Heat<br>Bottom ash<br>Fly ash<br>Metals<br>Hazardous gas clean-up residues | Hazardous gas clean-up residues | | Residuals to landfill | Heat<br>Digestate (compost)<br>Liquid digestate (fertiliser)<br>Residuals from feed decontamination |

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## 3.3 Value of EfW outputs

The value of EfW facilities' outputs is subject to market forces and can vary significantly. The value of EfW products sold internationally (metals or RDF), will be subject to the market price for the traded commodity, which is influenced by international developments (such as the impact China's National Sword policy has had on the recycling market), or the international price of oil and gas, and international demand.

### 3.3.1 Electricity

Connecting to the grid to distribute the electricity generated by EfW plants can be a costly and lengthy process. Richgro in WA reported that it took approximately 2 years to finalise the agreement with Western Power for its anaerobic digestion plant. Any technology option that is capable of generating electricity is likely to require a similar timeframe to connect to the grid and is advisable for negotiations to commence at the facility construction stage.

In NSW, the value of electricity produced is dependent on the contract that is struck with the Australian Energy Market Operator (AEMO) (Ricardo-AEA 2013). In the period 2010-2015, the average wholesale market price for electricity ranged between $29.78/MWh and $59.52/MWh (AEMO 2015). Assuming that waste entering the facility has a calorific value of 10 MJ/kg, and an energy recovery efficiency of 25% (the minimum required to meet the definition of an EfW facility under the NSW EfW Policy), it is estimated that the sale of electricity to the grid would be worth approximately $21 - $41/t waste input.

Power generation can prove an important secondary income source for thermal treatment facilities providing there is sufficient generation capacity to overcome the costs associated with establishing the connection to the grid.

### 3.3.2 Heat and Cooling

EfW facilities are generally configured to produce energy in the form of heat (either as steam or hot water) which is subsequently transmitted or converted to electricity. While electricity is comparatively easy to transmit over long distances (as long as a connection to the grid is feasible), transmission of heat energy requires an end user that is close to the facility otherwise the energy losses associated with transmission quickly become prohibitive.

The use of heating and cooling power from EfW facilities in parts of Europe and Japan is widespread due to the prevalence of district heating.

However, due to lack of district heating infrastructure in the ACT, the more likely outcome would be to supply heat to nearby energy intensive industrial users.

Estimating the value of heating and cooling power is much more complicated than estimating the value of electrical power. In general, studies have found that the value of heating and cooling is dependent on the following factors (Ricardo-AEA 2013):

- The quantity of useful heat that is generated is dependent less on the capacity of the EfW facility to produce heat and more on how much the end-user requires;
- Whilst electricity is the same regardless of how it is generated, there are many forms in which heat can be transmitted and used (depending in temperature, pressure and state of water); and
- Few EfW facilities have been designed as heat only facilities, rather most are operating as CHP facilities.

As such, the value of heating and cooling outputs will be determined by the agreement struck with the heat user.

### 3.3.3 RDF and PEF

Prior to producing RDF or PEF, the EfW facility should enter into a contract with a PEF user to agree on specifications and price. The cost of shipping should also be considered. The current market for RDF into the Asian market is of the order of -$50 per tonne and shipping costs will also need to be considered. The current negative market value of RDF may seem counter-intuitive, however the financial "value" in RDF supply lies in the avoidance of landfill costs. Provided the full cost of landfill (including operating costs, capital amortisation, aftercare and the landfill levy where applicable) is higher than the cost of processing material into RDF plus the cost of sending it to market, RDF facilities are able to rely on their gate fee for receiving the wastes to maintain financial viability.

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# 4 Key Australian EfW case studies

Table 8 demonstrates that interest in thermal treatment facilities in Australia is growing. However, currently there are no thermal solid waste EfW plants in operation. The following sections present the key operating and proposed thermal EfW facilities around the country.

Table 8 - Proposed thermal facilities in Australia

| Company | Proposed location | Cost | Waste feedstock (tpa) | Energy outputs (MW) | Technology type | Status |
|---|---|---|---|---|---|---|
| **New Energy** | Port Hedland (WA) | $180 million | 70,000 - 130,000 | 18.5 | Entech gasification | In development, to be commissioned in 2019 |
| **New Energy** | East Rockingham (WA) | $160 million | 130,000 | 18 | Entech gasification | In planning approval |
| **Phoenix Energy** | Kwinana (WA) | $400 million | 400,000 | 32 | Martin GmbH reverse-acting grate | In development. |
| **EMRC** | Hazelmere (WA) | $25 million | 13,000 Wood waste | 3.5 | Pyrolysis | Under construction. |
| **Dial-a-Dump** | Eastern Creek (NSW) | $700 million | 552,500 | 76 | Moving grate thermal treatment | Application currently being determined. |
| **We Kando** | Qld | Unknown | PE plastics & tyres | Unknown | Pyrolysis | Aspirational |

## 4.1 PEF manufacturing – ResourceCo Adelaide

For over 10 years, ResourceCo has operated a mixed waste MRF in Adelaide (Wingfield) as a joint venture with Suez, processing both C&D residuals and dry commercial waste to recover recyclables and produce PEF for use as a source of energy in a nearby cement kiln operated by Adelaide Brighton Cement. The PEF replaces around 20% of the kiln's natural gas demand.

The MRF sorts and directs mixed plastics, timber and textiles to a PEF stream while soil and masonry products are recycled. The plant has the capacity to process 350,000 tonnes of raw material annually however it currently only processes 150,000, producing 85,000 tonnes of PEF.

The MRF and manufacturing process consists of:

- Shredding and screening (to remove aggregates and sand);
- Hand sorting and removal of contaminants (steel, concrete, masonry etc); and
- Additional processing to produce PEF.

Table 9 - Summary of ResourceCo's RDF facility in Adelaide

| Facility and technology | Detail |
|---|---|
| **Capacity** | 350,000 tpa capacity but currently only processing 150,000 tpa |
| **Feedstock** | C&D and dry C&I waste (Wood, tallow, dried biosolids, wheat residues, rice hulls, woody component from composted garden organics, grape marc (residual skins from winemaking)) |
| **EfW technology** | MRF and PEF manufacturing |
| **Outputs** | 85,000tpa PEF |
| **Similar facilities** | Visy Smithfield RDF, ResourceCo Sydney RDF facility |

## 4.2 Anaerobic Digestion - Richgro

The Richgro anaerobic digestion plant was commissioned in March 2015 and is located in Jandakot, WA. The digestion process is stable (including steady pH levels) and the plant is generating over 5,000 $m^3$ of biogas per day at 65% methane with very low $H_2S$ levels (<200ppm).

A de-packaging process is utilised before AD to separate organic waste from packaging wastes. Recyclable materials such as PET bottles and aluminium cans are also recovered.

The project received funding/ grants from the following sources:

- Clean Energy Finance Corporation (CEFC) - $2 million loan;
- Australian Government Clean Technology Investment Program - $1.1 million grant; and
- WA State Government grant funding - $500,000.

Table 10 - Summary of Richgro's AD facility in Jandakot

| Facility and technology | Detail |
|---|---|
| **Capacity** | 50,000 tpa |
| **Feedstock** | Solid and liquid food waste from C&I sources |
| **EfW technology** | Anaerobic digestion |
| **Outputs** | 2 MW electricity<br>18,000 tpa of liquid fertilizer<br>2.2 MW thermal energy/heat used in hothouses to grow blueberries |
| **Similar facility** | Earthpower (NSW) |

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## 4.3 Proposed incineration - The Next Generation

The Next Generation (TNG), a part of the Dial a Dump Industries (DADI) Group, has proposed to construct and operate a $334 million, stand-alone EfW facility in Eastern Creek, NSW. A summary of the proposal is provided in Table 11.

Table 11 - Summary of TNG's proposed EfW Facility in Eastern Creek

| Category | Aspect | Detail |
|---|---|---|
| **Facility and technology** | Capacity | 552,500 tpa (down from 1.35 million in the original proposal) |
| | Feedstock | • Source: 32% from existing tonnes processed or received by DADI, 41% from a C&I processing facility to be established by DADI and 27% from tonnes to be sourced from external parties.<br>• Composition: 20% residual from mixed C&D processing, 12% residual from C&I recyclables processing, 41% residual from mixed C&I processing, 17% shredder floc, 8% wood waste and 2% textiles. |
| | EfW technology | Waste feedstock will be combusted using moving grate technology. Dioxins and emissions will be removed using two flue gas treatment systems. |
| | Electricity generation | 76 Megawatts (MW) – 68.7 MW for the grid and 7.3 MW used internally. |
| | Reference facility | Ferrybridge Multifuel (UK) |
| **Site** | Surrounding area | The closest residential properties are within 1 km from the site. |
| | Existing land use | Greenfield site |
| | Zoning | The land is zoned 'IN1 General Industrial'. |
| **Social value** | Job creation | 500 construction jobs and 55 jobs during operation |
| | Reduction in GHG emissions | 544,000 tonnes per annum |

TNG's proposal has been in the NSW planning system for nearly 5 years, its DGRs were issued in December 2013. The proposal was recently rejected by the NSW Department of Planning.

## 4.4 Proposed incineration – Phoenix Energy, Perth

In 2013 the City of Kwinana in Perth, WA and Phoenix Energy entered into a 20-year Waste Supply Agreement. In 2015 the project secured formal EPA support the project and was proclaimed a Level 2 State Development project. It has also secured contracts with the City of Kwinana, Rivers Regional Council and City of Canning. However, despite having relevant planning approvals, the project is still struggling to achieve financial close.

Table 12 - Summary of Phoenix's proposed EfW Facility in Kwinana

| Category | Aspect | Detail |
|---|---|---|
| **Facility and technology** | Capacity | Up to 400,000 t/a |
| | Feedstock | • Residual MSW from councils<br>• C&I waste |
| | EfW technology | Moving grate (equipment for the facility is to be supplied by Mitsubishi Heavy Industries Environment and Chemical Co, under licence from Martin GmbH) |
| | Electricity generation | 32MW of base load electricity to the grid. |
| | Reference facility | SMS Infrastructure Plant in Nagpur India, Hitachi Metals plants in Mihama/Mikata Yoshi and Utashinai, Japan |
| **Site** | Surrounding area | The closest residential properties are more than 3 km from the site |
| | Existing land use | Industrial |
| | Zoning | Kwinana Industrial Area |
| **Social value** | Job creation | 800 construction jobs and 60 jobs during operation |
| | Reduction in GHG emissions | 450,000 tonnes per annum |

## 4.5 Proposed RDF combustion - Energy Australia/Re.Group

Energy Australia (EA) and Re.Group are proposing to construct and operate an EfW facility co-located with the existing Mt. Piper Power Station in Lithgow, NSW. A summary of the proposal is provided in Table 13.

Table 13 - Summary of EA/Re.Group's proposed EfW Facility at Mt Piper Power Station

| Category | Aspect | Detail |
|---|---|---|
| **Facility and technology** | Capacity | 100,000 tpa |
| | Feedstock | • Source: RDF, to be provided by Re.Group.<br>• Composition: processed residual MSW and C&I. |
| | EfW technology | Waste feedstock will be combusted in a dedicated RDF boiler. |
| | Electricity generation | 12.5 Megawatts (MW) (unclear whether this is parasitic or net load) |

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| Category | Aspect | Detail |
|---|---|---|
| | Reference facility | Unstated, although the Boral cement kiln in Berrima, NSW (100,000 tpa of RDF and alternate fuels) has been cited in the Project Overview report. |
| **Site** | Surrounding area | The closest residential properties are within 4 km from the site. |
| | Existing land use | Disturbed land |
| | Zoning | The land is zoned 'SP2 Infrastructure'. |
| **Social value** | Job creation | 120 construction jobs and 15 jobs during operation |
| | Reduction in GHG emissions | 60,000 tonnes per annum |

The proposal is at the second stage of the NSW planning system, with the Secretary's Environmental Assessment Requirements (SEARs) issued in April 2017. The proponents are currently preparing a detailed Development Application and Environmental Impact Statement (EIS).

## 4.6 Incineration overseas

Although some incineration projects are proposed in Australia (Table 8) there are currently none in operation.

However, the approach is very different overseas where combustion technology is widely used and incinerators are commonly sited within cities. There are a number of technology providers offering a variety of proprietary furnace configurations, including moving grate, fluidised bed, and rotary kiln. In Europe, combustion technology is a central characteristic of the waste management system established for a number of cities. These plants serve to manage residual wastes and recover energy through power generation as well as district heating. As a result, they are located close to residential areas. Examples include:

- Riverside Resource Recovery Facility, UK (approximately 20km East of the City of London);
- Issy-les-Moulineaux, France (approximately 7km from Paris CBD and 3.6km SW of Eifel Tower);
- Lausanne, Switzerland (approximately 2km from the CBD and 100m from residential housing);
- Thun, Switzerland (approximately 500m from residential housing);
- Vienna, Austria (approximately 3km from the CBD); and
- SE London Combined Heat and Power plant, UK (approximately 5km from central London).

### 4.6.1 Overseas EfW facility ownership and management

EfW facilities overseas are owned and operated by a mixture of public and private organisations under various types of contractual arrangements including public private partnerships.

Examples include:

- ISSÉANE facility in Paris, France. 460,000tpa of MSW.

- Built by SYCTOM, the Waste disposal authority which represents the Western suburbs of Paris.
- Operated by TSI consortium, which is led by French renewable energy firm TIRU Groupe
- Tuas Incineration Plant, Singapore. 600,000tpa of MSW.
  - Government owned and operated by the National Environment Agency
- Keppel Seghers Tuas Waste-to-Energy Plant, Singapore. 300,000tpa of MSW.
  - Built under the National Environment Agency's Public Private Partnership initiative
  - Privately owned and operated by Keppel Integrated Engineering Limited (KIE)
- MVA Pfaffenau, Vienna, Austria.
  - The Wiener Kommunal-Umweltschutzprojektgesellschaft mbH (WKU) is a 100% subsidiary of the city of Vienna. The WKU was founded in 2002 to project, plan, build and finance the MVA Pfaffenau waste incineration.
- Ariake Incineration Plant, Tokyo, Japan. 140,000tpa of MSW.
  - Connected to Japan's first pneumatic waste-transport piping network.
  - Operated by Clean Association of Tokyo 23 (Group of Councils)
- Detroit Renewable Power, Detroit, USA.
  - Constructed by the city of Detroit in 1986.
  - Sold in 1991 to private investors to pay off city debt.
- Filborna waste-to-energy plant, Helsingborg, Sweden. 220,00tpa MSW.
  - Owned and operated by Öresundskraft AB (City of Helsingborg municipal energy utility).
- Laogang Incinerator Beijing, China. 1mtpa of MSW.
  - Operated by SMI Environment, a local state-owned enterprise.
- Bristol Resource Recovery Facility, Bristol, Connecticut, USA. 240,000tpa of MSW.
  - Covanta Bristol, Inc. owns and operates the plant under a 25-year agreement with the Bristol Resource Recovery Facility Operating Committee (BRRFOC), a consortium made up of: Berlin, Branford, Bristol, Burlington, Hartland, New Britain, Plainville, Plymouth, Prospect, Southington, Seymour, Warren, Washington and Wolcott.
- Wheelabrator South Broward Inc., Fort Lauderdale, Florida. 800,000tpa of MSW.
  - Privately owned and operated by Wheelabrator South Broward, Inc.

The mix of public/private owners and operators differs between countries. There is no global data for the ratio of public to private facilities, however the US Energy Recovery Council provides the following summary for the USA (Table 14). Section 8.1 provides a list of websites with additional information for EfW facilities around the world.

Table 14 - Ownership and operational status for the 77 EfW facilities in the USA.

| | Ownership | Operation |
|---|---|---|
| **Private** | **41** | 65 |
| **Public** | **36** | 12 |

# 5 Viability of EfW technology in the ACT

## 5.1 ACT context

The ACT waste strategy, Sustainability Policy and the Government's climate change policy agenda aim to achieve full resource recovery and a carbon neutral waste sector. Key targets are:

1. Carbon neutral waste sector;
2. Reducing the growth in waste generation to less than population growth; and
3. Diverting more of the Territory's waste from landfill to achieve resource recovery rates of over:
    a. 80% by 2015;
    b. 85% by 2020; and
    c. 90% by 2025.

Currently, ACT's resource recovery is around 70% and not carbon neutral. The following sections discuss how EfW technology could assist the ACT in improving those metrics.

## 5.2 Available streams and volumes

The ACT generated just over one million tonnes of waste in 2014/15 of which 70% was diverted from landfill. This equates to waste generation of 2.7 tonnes per capita[9].

The C&D stream makes up the largest proportion of waste generated and also has the highest diversion rate at 86%. This reflects well-developed C&D recycling infrastructure in the ACT, as well as the relative ease with which C&D waste can be recycled due to its lack of putrescible materials.

The lower C&I diversion rate (58%) largely reflects a lack of recycling collection services in commercial and industrial facilities. The diversion rate for MSW is the same as for C&I waste. A significant proportion of the recovered materials is vegetation that is collected separately (source separation).

The top four waste types generated in the ACT are masonry, vegetation, metals and paper & cardboard. With the exception of paper and cardboard, these materials all have a very high diversion rate of above 90%. Paper and cardboard has a diversion rate over 50%.

The top four waste types that are disposed to landfill are contaminated timber, rock/dirt/soil, food and paper & cardboard. The first three waste types have essentially no diversion from landfill.

Waste generation in the ACT is growing at an average rate of 0.5% per annum. Total waste disposal and recycling quantities are growing at an average growth rate of 2% per annum.

According to the ACT NoWASTE projection model that estimates the annual tonnes of waste arising and tonnes for disposal and recycling in the ACT during the period 2016 to 2035, waste disposal is projected to grow by 2.4% per annum. Therefore, by 2035 annual waste generation would have grown to 1.5 million tonnes per annum and in the 20 years prior to 2035, a combined 26 million tonnes of waste will be generated.

[9] The discussion in this section is derived from ACT NoWASTE data instead of National Waste Report data which is different for the same period as it uses a different methodology to allocate waste between states. ACT NoWASTE data is considered a more accurate representation of the ACT's waste streams.

## 5.3 EfW technology for ACT

An EfW facility in the ACT has the potential to be fully integrated into the current waste management system by providing an energy recovery step prior to final landfill disposal. This would help to:

- Preserve landfill void space and extend the life of Mugga Lane landfill
- Delay the need for establishing a new landfill or transporting waste to other facilities further away;
- Minimise greenhouse gas emissions from landfill; and
- Recover energy embodied in waste and generate electricity.

To determine which EfW technology would be more appropriate for ACT, a detailed options comparison would be necessary. However, given that AD and pyrolysis, and to a certain extent gasification, are either unproven or unsuitable for processing mixed solid waste, incineration and PEF manufacturing seem the more likely options.

To implement either of these technologies, the ACT would have to ensure that waste hierarchy principles are upheld and that EfW is applied to residual waste only after resource recovery of organics, plastics and metals has been maximised.

The 2017 Waste Strategy Roadmap 2018-2023 calculated that in 2017, a maximum of 227,500 of the total landfilled tonnes of waste was potentially combustible and therefore suitable for incineration or PEF manufacturing. ACT continues to explore ways of increasing higher order diversion (waste reduction, reuse and recovery) and therefore the waste potentially available for EfW is likely to be less than this amount. At the same time, waste generation is growing at 2.4% annually. Any future EfW facility planning should take into account both these factors.

A key difference between incineration and PEF manufacturing is that the latter is scalable and capacity can be gradually added or mothballed as needed and at a relatively low cost. Conversely, incineration requires significant upfront investment and infrastructure and therefore increasing a facility's capacity is not an easy task.

Since incineration requires large volumes of material, at the ACT's scale, it is likely to be less financially viable (especially if ACT is pursuing higher order recovery). Although incineration is a scalable technology, to do so would be expensive. Reducing throughput is an easier option technically, however this may render the plant financially unviable unless waste were to be imported, a measure which may not be politically attractive.

On balance, an RDF facility appears to be the preferred option because of scale, cost and political acceptability.

### 5.3.1 Biochar production through pyrolysis

Biochar is a promising material with beneficial properties when applied to soil and is currently the subject of worldwide research through, among others, the International Biochar Initiative. Commercial facilities for its production, however, are limited and accordingly prices are very high. The product remains commercially unproven despite its significant potential. Should the situation change, a pyrolysis plant producing commercial biochar would be appropriate for the ACT, but it should be noted that this will only treat source separated organic wastes because of the need to avoid product contamination.

# 6 Technology strengths and weaknesses summary

Strengths, Weaknesses, Opportunities and Threats have been identified for each of the technologies reviewed in Section 3.1. This section briefly discusses some additional strengths and weaknesses that apply to all the EfW technologies.

## 6.1 Benefits

### 6.1.1 Environmental

One of the drivers for EfW is achieving higher order resource utilisation than would be achieved with landfill disposal. EfW can recover metals and helps to avoid greenhouse gas emissions by both avoiding landfill disposal of organic waste, recovering energy from this waste and reducing the need for the extraction and processing of virgin materials such as metals and fossil fuels.

With appropriate environmental controls, the potential impact on the environment and human health is minimal and usually below that of other industries such as coal burning power plants. EU Industrial Emissions Directive (2010/75/EU) regulations represent world's best practice in this regard.

### 6.1.2 Community and social

Resource recovery infrastructure has the potential to create jobs for the local community, with a positive change in employment in moving from landfill disposal to resource recovery. According to the 2010 National Waste Report, recycling creates more than 9 jobs per 10,000 tonnes of waste processed compared to less than 3 jobs for landfill disposal.

EfW facilities tend to require a mixed workforce, comprised of manual labourers, skilled technicians, engineers, supervisors and managers. In addition to providing local employment at the facility, further jobs will be created in supporting and subcontracting roles in providing maintenance and other related services for the duration of the project's life.

### 6.1.3 Financial

Through the generation of electricity, the production of PEF and sale of recyclables, EfW facilities have the potential to generate income from material that would otherwise be disposed of to landfill. Moreover, through the creation of more on-site and off-site jobs than the equivalent landfill they have the potential to stimulate the local economy and community.

## 6.2 Risks and potential issues

### 6.2.1 Community and social

Establishing a EfW facility requires the approval of the local community (i.e. a social licence to operate). The Australian Centre for Corporate Social Responsibility defines this license as the level of acceptance or approval continually granted to an organisation's operations or project by the local community and other stakeholders. Based on the principles of environmental justice, the environmental benefits and impacts of a resource recovery facility should be distributed proportionately and affected communities should be able to participate in decision making.

Essentially this means that the ACT community should have the opportunity to participate in the process of establishing waste and resource recovery priorities and a say in the development of infrastructure directly affecting them. Key community and social issues to consider in the development of EfW include:

- Community acceptance of proposed solution;
- Approvals risk for controversial proposals;
- Ongoing operational stakeholder risks; and
- Reputational risks.

### 6.2.2 Financial

The financial viability of an EfW facility has to be ensured from the outset, via a detailed business plan. Risks that need to be identified and addressed include:

- Securing finance under affordable / acceptable terms;
- Associated conditions of any grant funding;
- Future cost of decommissioning
- Feedstock supply, quality and composition as it can significantly affect the financial viability:
  - Ability to control feedstock quality;
  - Security of feedstock volumes over the life of the project;
  - Impact of other recycling/recovery programs on future feedstock; and
- Gate fee compared to alternatives (including landfill).

### 6.2.3 Protecting human health and the environment

Although the EfW technologies put forward here are mature and tested technologies, there are some risks inherent to all industrial activity. Residue management and disposal and the associated costs are well understood potential risks along with manual waste handling, sorting, fire, explosion, potential failure of emissions clean up system and exposure to hazardous substances risks. Although not insignificant, these risks are readily identifiable and thoroughly minimised in all well-run waste management facilities.

The Environment Protection Act 1997 (the Act) sets the basis for waste regulation in ACT as it provides the regulatory framework to help reduce and eliminate the discharge of pollutants into the air, land and water.

The Act establishes the EPA and its powers, duties and functions to reduce risks to the environment and human health. Therefore, all works approvals, licences and financial assurances applying to EfW facilities would be managed through the EPA.

All EfW proposals are assessed in regard to site selection, design, construction and operation and must also comply with ACT's:

- Waste Management and Resource Recovery Act 2016
- Waste Management and Resource Recovery Amendment Act 2017.
- Waste Management and Resource Recovery Regulation 2017
- Air - Environment protection policy
- Draft Separation Distance Guidelines for Air Emissions

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- Planning and Development Management Act 2007

These requirements along with a future EfW policy will ensure that future any EfW facility is sited, designed, built and operated so as to minimise impacts on surrounding communities and the environment. Table 16 outlines the key risk management and mitigation actions that should be taken to ensure that the project safeguards human health and the environment and that it is viable in the long term.

### 6.2.4 Ash management

In combustion EfW, reuse of ash is widespread worldwide including in Europe and the USA. An ACT EfW facility could do the same and thereby achieve cost neutral ash management or even generate some income through the sale of bricks and pavers.

However, currently in ACT there is no legislation governing EfW ash management and no regulatory pathway exists for re-use. The default management approach would be disposal to landfill prior to proving beneficial re-use. An EfW operator would have to prepare and implement an Ash Reuse Management Plan to ensure that by-products meet all the necessary environmental criteria, such as content of heavy metals (mainly lead, cadmium, copper and zinc), dioxins and furans and are fit for use on an on-going basis.

This situation leaves EfW facilities in ACT exposed to two risks. First that they have to be able to prove the ash-based products (such as bricks and pavers) consistently meet the environmental criteria. This is done through leach tests to confirm that the material is non-hazardous and need not be classed as a controlled waste. If the ash-based products are not deemed environmentally stable, alternative management methods will be required. Landfill would be the fall-back option in which case the products would need to undergo a TCLP (*Toxicity Characteristic Leaching Procedure*) to determine if they should be characterised as hazardous waste. The cost of disposal at landfill is high, more so if the material is hazardous. If a facility generates a high proportion of bottom and fly ash per tonne of incinerated material, landfilling costs could run into millions of dollars annually, and this would need to be reflected in the facility's gate fees.

Should the ACT adopt regulations or controls under environmental protection legislation similar to that in NSW, which categorises incinerator ash (either all or just fly ash) as either not safe for use, or as hazardous waste, it would effectively mandate the landfill disposal of ash and thereby increase the facility's operating costs.

### 6.2.5 Emissions management

Thermal EfW facilities produce flue gas emissions. The quantity and type of pollutants in these emissions depend on the composition of the waste, the incineration technology used and the efficiency of the operation. On average, 6-7 $Nm^3$ of flue gas is generated per kg of waste.

Incinerators are fitted with air pollution control devices (APCD) to remove particulate matter, acid gases, dioxins, mercury and NOx emissions prior to discharging the combustion gases to the atmosphere. To achieve Europe's increasingly stringent regulations, more than one particulate-control device or more than one type of scrubber is fitted sequentially in a best practice incineration facility[10]:

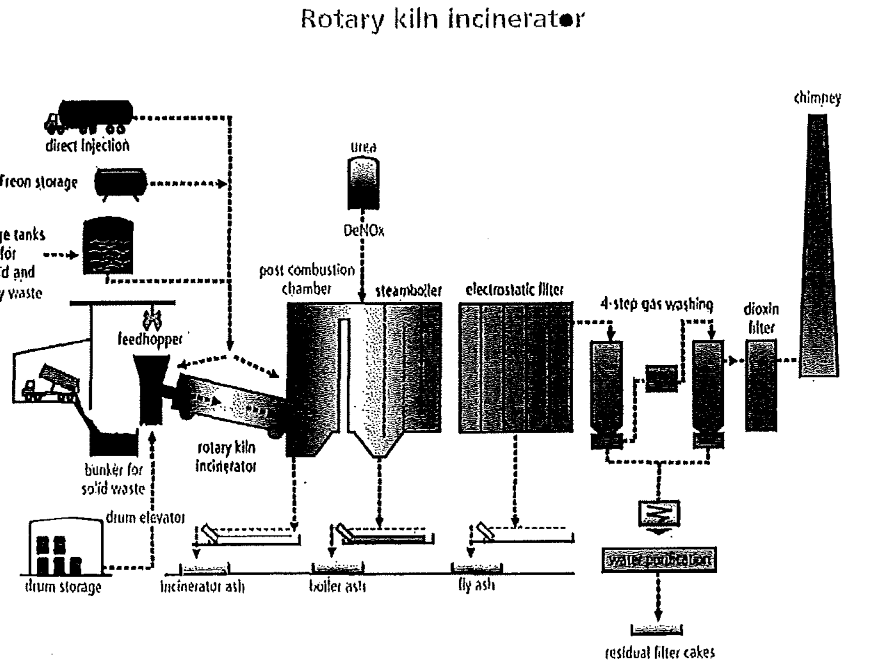
- fabric filters and/or dry/wet electrostatic precipitators are used for particulate (dust) removal;

[10] National Research Council (US) Committee on Health Effects of Waste Incineration. Waste Incineration & Public Health. Washington (DC): National Academies Press (US); 2000. 3, Incineration Processes and Environmental Releases. Available from: https://www.ncbi.nlm.nih.gov/books/NBK233627/

- spray dryer absorbers and dry-lime injection systems (scrubbers) are used for acid gas (HCl) and sulphur dioxide removal;
- combustion control and/or dry powdered activated carbon injection systems are used for dioxin and furan and mercury removal; and
- $NO_x$ emissions can be reduced by combustion-furnace designs, combustion-process modifications, or add-on controls including selective noncatalytic reduction (SNCR), selective catalytic reduction (SCR), and wet flue-gas denitrification.

Figure 5 shows a simplified flow process of the flue gas cleaning system in a rotary kiln incinerator.

**Figure 5 - Sample rotary kiln incinerator flue gas cleaning system (Source: Indaver[11])**




Gasification and pyrolysis employ similar methods and technologies to minimise emissions. RDF/PEF production and AD facilities do not emit hazardous substances. However, at facilities where RDF/PEF is burnt, emissions controls similar to those for incinerators may be required.

#### 6.2.5.1 Emissions limits

Australian states have not set universal emissions limits for EfW facilities. Project proposals generally undertake to comply with EU's Industrial Emissions Directive (2010/75/EU) emission limits, which are currently the most stringent in the world. The key air pollutants from EfW facilities are the same as those released by coal fired power stations; in NSW these contribute the largest share of pollutants such as sulphur dioxide. Emissions from EfW facilities should be considered from this perspective.

[11] http://www.indaver.be/en/installations-processes/waste-to-energy/rotary-kilns/

Recently, the NSW EPA (2018) released its Review of *Coal Fired Power Stations Air Emissions and Monitoring* which identified that there are inconsistencies in emissions limits between power stations. This is because there are no state-wide limits but rather limits have historically been set on a case by case basis through the station's license conditions. As an example, the review highlighted that although the Vales Point and Eraring power stations are only 25 km apart, air emissions limits differ significantly. The former is allowed to emit concentrations of fine particle pollution that were twice those permitted for the later while permitted mercury concentrations were also five times higher for Vales Point.

Overall, NSW and Australian coal fired power stations are allowed to release levels of air emissions that would be illegal in the US, Europe and China. Accordingly, many Australian power stations do not implement pollution reduction technologies that are installed in overseas facilities. As shown on Table 16, the EU air pollutant emission limits set by the Industrial Emissions Directive, require significantly lower release of air pollutants than any of the Australian coal fires power plants.

Table 15 - Major air pollutant emission limits in power stations around the world and EfW facilities in the EU

| Power station | Particles ($mg/m^3$) | Sulphur dioxide ($mg/m^3$) | Nitrogen oxides ($mg/m^3$) | Mercury ($mg/m^3$) |
|---|---|---|---|---|
| **EU EfW** | 10 | 50 | 200 | ~2.4[12] |
| **EU coal** | 50 (black coal)<br>100 (brown coal) | 400 | 200 | 30 (Germany only) |
| **China coal** | 30 | 200 | 200 | 30 |
| **USA coal** | 125 | 1,517 | 875 | 1.5 (black coal)<br>14 (brown coal) |
| **Vales point coal (NSW)** | 100 | 1,716 | 1,500 | 1,000 |
| **Eraring coal (NSW)** | 50 | 1,716 | 1,100 | 200 |
| **Gladstone coal (Qld)** | 150 | No limit | 2,800 | No limit |
| **Loy Yang A coal (Vic)** | 258 | 2,370 | 677 | 30 |
| **Yallourn coal (Vic)** | 190 | 820 | 407 | No limit |
| **Loy Yang B coal (Vic)** | 149 | 2,692 | 678 | No limit |

12 Average emission limit value of 0,05 $mg/Nm^3$ for mercury over a sampling period of a minimum of 30 minutes and a maximum of 8 hours.

# 7 Community/stakeholder engagement and project approval

## 7.1 Overview of community/stakeholder reactions to EfW projects in the ACT

The limited ACT experience with EfW projects mirrors the outcomes in NSW where incineration projects progressed to latter stages of the application process (section 7.2.2). Both EfW projects proposed in the ACT did not sufficiently address the community's concern. Significant community opposition eventually contributed to cancellation of both proposals.

### 7.1.1 Capital Recycling Solutions incineration

An EfW proposal was recently submitted by Capital Recycling Solutions (CRS). The CRS proposal intended to burn waste in a mass burn incinerator, generating electricity. The proposal envisaged a plant designed to receive up to 400,000 tonnes of waste per year, comprised of all combustible waste going to Mugga Lane landfill augmented by additional waste from interstate. However, recently CRS withdrew its proposal citing community and government opposition to the project[13].

### 7.1.2 Foy Group waste to diesel

In 2016, the Foy Group proposed a waste to diesel facility which attracted local attention, with residents concerned about the impact of emissions from the facility on public health and the environment. Underlying these objections are likely to be concerns regarding EfW facilities in general. The proposal was ultimately refused.

## 7.2 Other jurisdictions - the example of NSW projects

In the absence of major EfW project proposals in ACT, the different approaches that the TNG and EA/Re.Group proposals have taken to address NSW's EfW Policy provide useful examples for organisations considering entering the EfW market. While the specifics of the examples below relate to NSW, the lessons learnt apply to all jurisdictions.

The key takeaway lessons are summarised in Table 16.

Table 16 - Schedule of lessons learnt for each stage

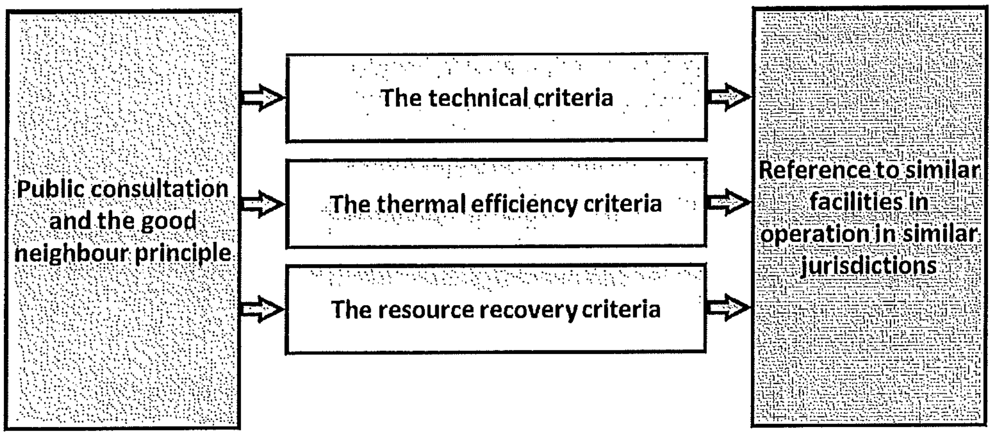
| Stage | Lesson |
|---|---|
| **Preliminary activities** | Select a proponent, or create a partnership, with a good public image. |
| | Engage with the community and key stakeholders early on, ensuring that their feedback is reflected in the development of the project scope (e.g. location, scale of the facility, proposed feedstock). Beyond the local community, stakeholders include:<br>• Relevant local councils;<br>• Relevant Regional Organisations of Councils (ROCs); |

[13] https://www.canberratimes.com.au/politics/act/capital-recycling-takes-waste-to-energy-off-the-table-in-the-act-20180607-p4zk2v.html

| Stage | Lesson |
| --- | --- |
| | • Local health districts;<br>• NSW Health (or equivalent public health agency);<br>• Department of Planning & Environment, including the NSW EPA; and<br>• Special interest groups (for the TNG proposal these included the Total Environment Centre and the National Toxics Network). |
| **Project feasibility** | Ensure that a suitable reference facility has been identified. The facility must be currently in operation in a similar jurisdiction and must have a similar waste feedstock (e.g. MSW, C&I, RFD). |
| | The choice of waste feedstock has implications for addressing the technical criteria and reference facility requirement. C&D feedstock adds an element of difficulty, due to there being less reference facilities and the higher temperature requirements will need to be applied. The choice of RDF feedstock has many precedents around the world and allows for certainty in feedstock composition over time. |
| | Ensure that the waste feedstock has been thoroughly researched in terms of availability of material. "Detailed, site-specific information" is required for each processing facility or generator from where the feedstock will be sourced. Any references to sourcing feedstock on a merchant basis may not be favourably received. |
| | Ensure that the project scope aligns with the relevant waste and resource recovery strategies. |
| **Preparing the development application and EIS submission** | Ensure that the waste feedstock has been identified on a processing facility level. In NSW, under that jurisdiction's EfW Policy, EfW facilities must be tied to a feeder processing facility that ensures higher order resource recovery outcomes are achieved before residual is diverted to energy recovery (except in the case of tyres, textiles and waste wood being used as feedstock). |
| | Ensure that 'potentially hazardous materials' are not included in the waste feedstock. |
| | Ensure that sufficient controls are implemented to minimise variability in the feedstock composition over time. This is essential to validating the emissions modelling and human health assessment. |

Although the three criteria of the NSW EfW policy are often considered as the basis of the policy requirements, there are five elements of the EfW policy (Figure 6), which are key to the assessment process in that state. This section will review the approach of both proposals to each element, beginning with lessons learnt from the DP&E's Assessment Report of the TNG proposal ("the Assessment Report") and followed by commentary on the approach of the EA/Re.Group proposal.

Figure 6 - The five elements of the NSW EfW Policy




### 7.2.1 Reference facility requirement in NSW

Regarding the reference facility requirement, the EfW Policy states:

> *"[Energy recovery facilities] must... demonstrate that they will be using current* ***international best practice techniques...***
>
> *Energy recovery facilities must use technologies that are proven, well understood and capable of handling the expected variability and type of waste feedstock.* ***This must be demonstrated with reference to fully operational plants using the same technologies and treating like waste streams in other similar jurisdictions.*** *(pg. 6)"*

The Assessment Report makes clear that the existence of a reference facility is considered as important "evidence" for demonstrating compliance with the EfW Policy.

The Assessment Report clarifies that the reference facility's waste feedstock must be aligned on a waste stream basis (i.e. municipal solid waste (MSW), separated waste streams, mixed C&D etc.) rather than simply on a chemical composition basis (e.g. carbon, hydrogen, water etc.). Furthermore, it is now understood that the reference facility's operational waste feedstock, rather than its design feedstock, should be comparable with that of the proposed facility.

The TNG proposal adopted a reference facility that was comparable in terms of technology, capacity, feedstock Net Calorific Value (NCV) and feedstock chemical composition. However, the reference facility was deemed inappropriate by the DP&E based on the material composition of the proposed feedstock, which differed from the reference facility's design and operational feedstock material composition. The proposed feedstock comprised of mixed C&I waste, MRF residual, mixed C&D, floc waste and other streams, while the reference facility's design feedstock consisted mainly of RDF (sourced from MSW and C&I sources), which was considered by the Assessment report as a category distinct from mixed C&D and mixed C&I.

The EA/Re.Group proposal has the benefit of a potential reference facility already approved for development in Australia, the Boral cement kiln in Berrima, NSW which processes 100,000 tpa of RDF.

### 7.2.2 Community acceptance

Regarding the public consultation and good neighbour principle requirements, the EfW Policy states:

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*"Energy from waste can be a valid pathway for residual waste where... **community acceptance** to operate such a process has been obtained. (pg. 1)*

*... it will be **essential that proponents provide effective information and public consultation** about energy from waste proposals. As proposals progress from the concept to detailed development assessment stage, proponents should **engage in a genuine dialogue with the community** and ensure that planning consent and other approval authorities are provided with accurate and reliable information.*

*The operators of an energy from waste facility will need to be **'good neighbours'** – particularly if near a residential setting but also where there are workers in other facilities. This would apply to waste deliveries and operating hours, but most importantly with respect to readily available information about emissions and resource recovery outcomes. (pg. 4)"*

The Assessment Report cites public acceptance as a one of the key elements of its refusal of the TNG proposal, stating: "the Applicant has been unable to gain the community's acceptance of the proposed development". The various elements of 'community acceptance' include:

- Submissions from the public, relevant stakeholders and special interest groups. 98% of submissions from the public objected to TNG's amended EIS.
- Limited political interest and controversy regarding the proposal. Two bills were introduced to the NSW Parliament in opposition to the TNG proposal and a NSW Parliamentary Inquiry was held in relation to energy from waste, specifically recommending against the TNG proposal in its findings. Furthermore, three federal MPs, representing nearby electorates, objected to the proposal on the grounds of insufficient engagement and "strong community opposition".
- Petitions and social media advocacy groups against the proposal. The TNG proposal has attracted 3 petitions, 2 of which attracted over 10,000 signatures and were discussed in NSW Parliament. Furthermore, a social media group 'No Incinerator for Western Sydney' was created.

While TNG undertook public consultation activities, as required by its Director General's Requirements (DGRs), most of the submissions to the proposal were negative, indicating that the consultation did not sufficiently address the community's concerns. Public consultation should commence during the preliminary stage, before a development application is submitted, to ensure that the proposal can incorporate key feedback from public consultations. The DP&E suggests in the Assessment Report that a community liaison or advisory group would have been appropriate.

Furthermore, in relation to demonstrating the need for the development per EIS requirements, it should be noted that EfW proposals should be consistent with relevant waste and resource recovery strategies. For the TNG proposal, these included the Greater Sydney Regional Plan, the Central City District Plan, the NSW Waste Avoidance and Resource Recovery Strategy 2014-21, the Draft Waste and Resource Recovery Infrastructure Strategy 2017-21, the Western Sydney Waste Avoidance and Resource Recovery Strategy 2011-2017, and the Western Sydney Regional Waste and Recycling Infrastructure Needs Assessment. The TNG proposal mostly fell short of addressing these strategies in terms of the scale of the facility and the waste streams targeted for feedstock material.

The EA/Re.Group proposal commenced stakeholder engagement before the project entered the development proposal phase. This included briefing the Community Reference Group for the Mt. Piper Power Station, relevant local councils and state government representatives and departments. Furthermore, the proponents will utilise EA's existing community relations program as part of the public consultation process, which includes regular stakeholder meetings, community tours of the power station and independent community surveys. Support from the Australian Renewable Energy Agency (ARENA) was also gained in the initial stages of the project, with ARENA contributing $400,000 in funding for the feasibility study.

### 7.2.3 Addressing the technical criteria

The lack of a reference facility that is fully aligned with the TNG proposal, particularly in terms of the material composition of the feedstock, resulted in a cascading effect on the entire proposal, including in addressing the technical criteria. The Assessment Report cites the potential variability of the waste feedstock mix (varying in "composition and characteristics over time") as a human health risk. This was the determining factor that undermined the TNG proposal's air quality impact assessment and documentation regarding its adherence to Group 6 emission standards. It was considered that variability in the waste feedstock would reduce the certainty of emissions modelling undertaken for the facility and, ultimately, the ground level concentrations of chemicals from the facility's emissions over the life of the development. Based on an inappropriate reference facility, assumptions and data used for estimating human health impacts were thus considered unreliable and uncertain.

Furthermore, TNG's choice of locating the proposed facility in a densely populated urban area, 1 km away from the nearest sensitive receiver, was raised as grounds for refusal in the Assessment Report. In conjunction with the DP&E's assessment of the project's air quality impact, the location of the facility was considered a potential human health risk that was not in the 'public interest'. On the other hand, the EA/Re.Group proposal is based in a low-density, regional area, with the nearest sensitive receiver 3km away from the site. This significantly reduces the 'public interest' element to the air emissions requirements of the technical criteria.

Furthermore, the Assessment Report for TNG clarifies that the choice of C&D feedstock and wood waste is considered as potentially containing halogenated substances, which in turn may result in chlorine levels exceeding 1% during the life of the project. This assessment was made despite the TNG proposal detailing a quality control process for sorting such materials out of the feedstock. Therefore, in practice, the choice of C&D or wood waste feedstock will likely require the proponent to meet the higher temperature and residence time requirements stated in the EfW Policy (i.e. > 1100°C, rather than only 850°C, for at least two seconds).

### 7.2.4 Addressing the thermal efficiency criteria

The thermal efficiency criteria are designed to ensure that EfW facilities achieve a minimum standard for electricity production. The choice of EfW technology determines whether the proposal will meet the thermal efficiency criteria. The criteria were met by the TNG proposal. In respect of the EA/Re.Group proposal, the available documentation does not currently address the thermal efficiency criteria and will likely be addressed in the Environmental Impact Statement.

### 7.2.5 Addressing the resource recovery criteria

The Assessment Report for TNG provided several clarifications regarding the practical application of the NSW EfW Policy. It made clear that shredder floc is considered a hazardous material per the EfW Policy and is thus ineligible as a feedstock for EfW facilities in NSW. Furthermore, stating that certain eligible waste materials (e.g. wood waste, textiles and mixed C&D, to be processed by a facility owned by the proponent) will be sourced from the market was described as an "unjustified increase" in waste streams.

The Assessment Report also clarified the practical application of the % limits for determining the eligibility of tonnes for energy recovery, defined in Table 1 of the EfW Policy with reference to the input tonnes to a

MRA Consulting Group

processing facility. The application of the % limits to the aggregated input tonnes of multiple (real) facilities was deemed inadequate to justify the availability of eligible feedstock, the scale of the facility and was seen as being in contravention of the EfW Policy. Rather, the % limits must be applied to individual processing facilities, "detailed, site-specific information" must be provided for each and the proponent must demonstrate that the "appropriate type and amount of waste is being used for energy recovery".

While the EA/Re.Group proposal is still at an early stage, details in relation to the resource recovery criteria have already been provided in the Project Overview report. The report identifies RDF as the waste feedstock, and states that the RDF feedstock will be tested against "pre-defined specifications and quality control requirements" at external processing facilities in the Greater Sydney area, before being transported to the power station.

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## 8.1 Online resources

- **19 countries** ISWA 6th Edition of the *State*-of-the *Art Report* on *Waste*-to-*Energy* plants, list with information on EfW facilities in Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Italy, Ireland, Netherland, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland, United Kingdom and USA https://www.iswa.org/index.php?eID=tx_iswaknowledgebase_download&documentUid=3119
- **EU** CEWEP – Confederation of European Waste to Energy Plants http://www.cewep.eu/
- **UK** Full list of operational energy from waste (EfW) plants in the UK http://www.wrap.org.uk/content/list-energy-waste-sites
- **USA** Energy Recovery Council- Directory of Waste to Energy Facilities including information on ownership and operational structure http://energyrecoverycouncil.org/wp-content/uploads/2016/05/ERC-2016-directory.pdf
- **Switzerland** List and map of all EfW facilities http://vbsa.ch/anlagegruppen/kva/
- **Hitachi Zosen** (technology provider)- Energy from waste facilities worldwide http://www.hitachizosen.co.jp/english/pickup/pickup002.html
- List of **1,600 EfW** facilities around the world with location links to Google maps http://www.coenrady.com/1600WTE_D20.xlsx

ACT Government

MINISTERIAL BRIEF

**Transport Canberra and City Services**

UNCLASSIFIED

| | | |
|---|---|---|
| **To:** | Minister for Transport and City Services | Tracking No.: B17-124 |
| **From:** | A/g Director-General, Transport Canberra and City Services | |
| **Subject:** | Capital Recycling Solutions Recycling and Waste-to-Energy Plant | |
| **Critical Date:** | 21 July 2017 | |
| **Critical Reason:** | Immediate media and community interest | |

**Purpose**

Today's Canberra Times has published a front page article on a proposal by Capital Recycling Solutions to develop a recycling and waste-to-energy plant at Fyshwick.

This brief provides some information and speaking points on this matter.

**Recommendations**

That you note the information contained in this brief.

**Noted / Please Discuss**

Meegan Fitzharris MLA ............[signature]............ 24/7/2017

Minister's Office Feedback please provide a status update on waste feasability study progress, as well as a briefing on the market sounding exercise & outcomes.

**Background**

1. Capital Recycling Solutions Pty Ltd (CRS) has submitted a proposal for a recycling and waste-to-energy facility at 16 Ipswich Street in Fyshwick. This is the site of the former fuel depot.
2. ACT Planning and Land Authority is about to commence an Environmental Impact Statement process for this proposal.
3. CRS is a joint venture formed by [redacted] The Canberra Times article notes CRS will partner with Actew AGL, through a 50:50 joint venture, to deliver the waste-to-energy plant.
4. The proposal will seek both kerbside garbage (red-lid) bin waste as well as commercial garbage that currently goes to landfill.

5. [redacted]

6. [redacted]

7. [redacted]

8. On 12 September 2017, in response to the number of unsolicited bids being received by the Territory, the Director-General of TCCS wrote to the waste industry advising of the intention to undertake a market sounding.

9. [redacted]

10. [redacted]

11. [redacted] Regional Council expressed support for this proposal at a meeting with you in your office on 27 April 2017.

**Issues**

12. It is encouraging that the waste sector views the ACT as a good place to investment in new waste management infrastructure.

13. [redacted]

14. However caution should be exercised in providing an opinion publicly on the particular merit of the [redacted] proposal whilst it is subject to an EIS process.

15. [redacted]

16. [redacted] proposes to [redacted]

17. The *ACT Waste Management Strategy 2011-2025* contains a strategy to "investigate new energy-from-waste technologies to generate energy".

18. The viability of the [redacted]

19. [redacted] will [redacted]

20. [redacted]

21. The facility if approved would be subject to license conditions imposed by the EPA and Waste Manager under the *Waste Management and Resource Recovery Act 2016.*

22. Opponents of waste-to-energy raise concerns about the lack of a waste-to-energy regulatory policy in the ACT, and point to the NSW EPA policy as an example of the type of policy the ACT should adopt. The NSW EPA regulatory policy is particularly restrictive, and there is no consistency in regulatory policy across jurisdictions.

23. The article incorrectly states that Mugga Lane is close to running out of space. This statement is not correct. Subject to provision of funding for future cells, stage 5 of the Mugga Lane landfill has capacity for the foreseeable future. The 2017-18 Budget contains funding for cells 3 and 4, which will provide landfill capacity until 2023.

**Speaking Points**

24. The following speaking points will address key issues:

a. The Territory is encouraged by the interest from the waste sector in investing in the ACT.

b. The proposal is subject to a formal Territory environment impact and planning assessment processes. These processes provide for wide-spread community consultation.

c. The FOY Group proposal was subject to Territory environmental impact and planning processes and was not endorsed.

d. The Government will receive the Waste Feasibility Study's report in October this year, which will contain recommendations on future treatment of waste in the ACT.

e. The WFS report is expected to provide recommendations on the development of appropriate regulatory policies, noting there is not a consistent approach across Australia.

f. The Canberra Times article incorrectly states the ACT is running out of landfill capacity at Mugga Lane. There is enough space in Stage 5 of the Mugga Lane landfill to meet the ACT's needs for the foreseeable future, and waste going to the Mugga Lane landfill has plateaued.

**Financial Implications**

25. Nil.

**Consultation**

26. Nil.

**Benefits/Sensitivities**

27. As discussed above.

**Media Implications**

28. This matter is attracting media interest. EPSD have issued a media release (Attachment A).

21.7.17

| | | |
|---|---|---|
| Signatory Name: | Jim Corrigan | Phone: x78658 |
| Action Officer: | Michael Trushell – Director, ACT NOWaste | Phone: x72840 |

MINISTERIAL BRIEF

ACT Government

**Transport Canberra and City Services**

UNCLASSIFIED

| | | |
|---|---|---|
| **To:** | Minister for Transport and City Services. | Tracking No.: B17/174 |
| **From:** | Director-General, Transport Canberra and City Services | |
| **Subject:** | ACT Waste Feasibility Study status update and Market Sounding outcomes | |
| **Critical Date:** | In the normal course of business | |

**Purpose**
To provide you an update on the progress of the ACT Waste Feasibility Study final report and the outcomes of the recent Market Sounding.

**Recommendations**
That you:

1. Note the information contained in this brief and Attachment A, Attachment B and Attachment C.

   **Noted / Please Discuss**

2. Agree to the preliminary findings of the Waste Feasibility Study being presented to the Economic Development Subcommittee of Cabinet at the next available opportunity.

   **Agreed / Not Agreed / Please Discuss**

3. Agree to the Economic Sub-Committee of Cabinet Submission at Attachment D.

   following verbal briefing on 29/8 at TCCS meeting - note questions overleaf

   **Agreed / Not Agreed / Please Discuss**

Meegan Fitzharris MLA ........................ 24/8/2017

Minister's Office Feedback
Slide 12 needs more explanation.
~~Please outline likely 2018-19 budget proposals~~
during 29/8 meeting. Thanks

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**Background**

1. The ACT Waste Feasibility Study (the Study) is a two year project funded in the 2015-16 Territory Budget with $2.8 million over two years.

2. The purpose of the Study was to provide strategic options to the Territory to achieve the objectives of its *Waste Management Strategy 2011-2025*, which include achieving 90 per cent resource recovery by 2025 and a carbon neutral waste sector by 2020. will we meet these targets?

3. Major achievements of the Study to date include:
   - Establishment of detailed baseline of the Territory's waste generation and resource recovery rates based on 2014-15 data;
   - Development of a performance based contract for the Hume Materials Recovery Facility for improved 'yellow bin' resource recovery outcomes;
   - Establishment of a new regulatory framework for the Territory's waste industry including the development of the *Waste Management and Resource Recovery Act 2016* (the WMRR Act) and related regulations which came into force on 1 July 2017;
   - Establishment of the 'Soft Landing' mattress recycling social enterprise at Hume;
   - A Market Sounding exercise which invited industry to present its capability and capacity to contribute to the achievement of Territory's waste resource recovery targets;
   - Management of the ongoing review of the Development Control Code (DCC) for Best Practice Waste Management in the ACT; and
   - Ongoing consultation with several reference groups representing government, commercial interests and community members.

**Overview of final report content**

4. The final report (the report) is being finalised with the assistance of nation leading waste industry consultants, Mike Ritchie and Associates (MRA). A presentation on the preliminary content of the report is provided in Attachment A.

5. The report will focus on the actions noted in the waste hierarchy, which is consistent with the Government's existing *Waste Management Strategy 2011-2025*, and incorporates concepts of the 'circular economy'.

6. The report will recommend measures that aim to increase the re-use of materials and reduce food waste, as well as regulatory interventions to improve waste management practices in local businesses and the construction and demolition sector.

7. Recommendations of the report could form the basis of a 'Roadmap' that identify initiatives for the Territory to consider over the period 2018-2025 to achieve resource recovery targets. This is presented in the diagram on slide number 12 in Attachment A.

8. The Road map aims at delivering incremental gains in resource recovery from the existing level around 70 per cent towards 90 per cent by 2025.

9. A key recommendation of the report is to significantly recover the amount of organic material being sent to landfill. The major benefits of this are two-fold:
    a. Organic material is responsible for the majority of greenhouse gas emissions from landfill. Removal of the organic material is in-line with the Territory's target of carbon neutrality by the year 2050; and
    b. Recovering organic material from landfill complements the Territory's existing 'green bin' pilot and roll-out over the next two to three years, and provides an opportunity for a food organics and garden organics (FOGO) collection service. Such service is likely to require increased organics processing capacity in the ACT or surrounding region.
10. The report will not recommend waste-to-energy processes until all other high-value options for resource recovery are exhausted. The final step in the roadmap recommends the exploration of a Process Engineered Fuel (PEF) facility, as a last resort, for waste remaining after all other measures are undertaken to divert waste resources to their best and highest use.
11. PEF would see the Territory's residual waste sold in national or international markets for use in either waste-to-energy plants or cement kilns. MRA has indicated that the Territory's municipal waste volumes alone would not support a viable thermal treatment waste-to-energy plant. , but what if waste comes from interstate?
12. The report is likely to recommend that the Territory develop a waste-to-energy policy to provide a framework for assessing relevant future proposals and to provide greater certainty to industry.

**Timing of the final report**

13. A timeframe of necessary inter-directorate consultation and approvals of the final report are detailed in Attachment B.
14. MRA was engaged in May 2017 to assist in reviewing the Study's work to date and to compile the Roadmap outlined above. The Roadmap is expected to be finalised in late August 2017.
15. ACT NOWaste will augment the MRA report with appendices outlining necessary considerations such as education and behavioral change campaigns, regulatory options, spatial/infrastructure planning considerations for the ACT and an overview of the Study's consultation and governance processes.

**Outcomes of the Market Sounding**

16. A Market Sounding was undertaken by the Study from February to April 2017. It invited the waste industry to provide examples of capacity and capability to deliver infrastructure or services which would contribute to the achievement of the Territory's waste management objectives.
17. The Market Sounding closed on 14 April 2017 and 31 submissions were received. The nature of respondents varied greatly, from global operators to SMEs.
18. Many of the submissions involved potential waste-to-energy solutions using a range of different technology options. A number of the respondents also provided details on

their capabilities in respect of the Container Deposit Scheme with the knowledge that the ACT Government has committed to implementing a scheme in early 2018.

19. Several submissions were related to the processing of FOGO materials.

20. Infrastructure consultants ISG Projects were engaged to provide advice on designing the Market Sounding and interpreting the submissions received.

21. Several key themes highlighted through the Market Sounding submissions:

    a. The industry would require government to make relevant regulatory planning and policy decisions to facilitate the majority of proposals put forward. Industry also referred to the absence of a waste-to-energy policy in the ACT;

    b. Community engagement and expectation management would be critical to most proposals put forward;

    c. Certainty around the commercial and contract terms relating to supply of the Territory's municipal waste feedstock would be critical prior to any procurement process;

    d. Industry identified risks relating to changes in composition of the waste streams, reliability of technology, and uncertainty around future access to commercial waste which may be redirected to intestate landfill if the Territory's gate fees are uncompetitive; and

    e. A number of submissions involved consideration of renewable energy feed-in-tariffs or other carbon price mechanisms.

22. Attachment C provides a 15 page overview of the Market Sounding by ISG Projects, as well as recommendations for any future procurement processes.

**Issues**

23. The final report of the Study was due to be presented to government in mid-2017 and is now expected to be presented for government consideration in October 2017. Key stakeholders were informed of the revised timing of the final report through the inter-directorate Waste Steering Committee, and at commercial and community reference group meetings held in late April.

24. The recent ABC television program 'War on Waste' and local media coverage of the Capital Recycling Solution Pty Ltd proposal for a waste-to-energy plant in Fyshwick (B17/164), are likely to have elevated public interest in the Study's final report and its recommendations.

**Financial Implications**

25. Financial implications of the report recommendations will be presented by comparing the cost of the new initiatives with existing landfill construction, management and remediation costs, as well as the impacts on revenue raised through landfill gate fees for commercial operators.

26. The Study's final report and key recommendations are intended to form the basis of Cabinet Submission, subject to Ministerial approval. The series of projects and initiatives put forward are also intended to underpin an integrated 2018-19 Budget

business case to implement next steps.

**Consultation**

27. The Study has been managing ongoing consultation with several reference groups representing government, commercial interests and community members.

**Benefits/Sensitivities**

28. As outlined in a previous brief on 24 July 2017 (B17/164), Capital Recycling Solutions has submitted a proposal for a waste-to-energy facility on a site in Fyshwick for planning approval. Stakeholders involved in consultation for the Waste Feasibility Study and Market Sounding may pose questions to the government about the proposal.

**Media Implications**

29. It is anticipated that the Fyshwick waste-to-energy proposal will receive further media attention.

30. The ABC's 'War on Waste' has generated increased interest in waste management issues at the national level and locally, evidenced through an increase in correspondence received by TCCS.

| | | |
|---|---|---|
| Signatory Name: | Director-General, Emma Thomas | Phone: 62078658 |
| Action Officer: | Deputy Director-General, Jim Corrigan | Phone: 6207 5819 |

**Attachments**

| Attachment | Title |
|---|---|
| Attachment A | Presentation – Preliminary contents of the WFS final report |
| Attachment B | Timetable of final report consultation and approvals processes |
| Attachment C | Executive Summary of the ISG Projects report on the Market Sounding |
| Attachment D | Economic Subcommittee of Cabinet Waste Feasibility Study Final report |

MINISTERIAL BRIEF

ACT Government

Transport Canberra and City Services

UNCLASSIFIED

| | | |
|---|---|---|
| To: | Minister for Transport and City Services | Tracking No.: B17/285 |
| From: | Director-General, Transport Canberra and City Services | |
| Subject: | ACT Greens Waste Policy Framework | |
| Critical Date: | In the normal course of business | |

**Purpose**
To brief you on the ACT Greens position on waste management and waste-to-energy, and implications for the Waste Feasibility Study and ACT Waste Management Strategy.

**Recommendations**
That you note the information contained in this brief.

Noted / Please Discuss

Meegan Fitzharris MLA ............................................... 16/11/17

| Minister's Office Feedback |
|---|
| |

**Background**

1. Minister Rattenbury wrote to you twice on 20 October 2017 expressing concerns about waste-to-energy proposals in the ACT at Attachment A.
2. The first letter is written in his capacity as an ACT Greens member for Kurrajong, which references the new ACT Greens Waste Policy Framework, and canvases the possibility of incorporating its key principles into the ACT's Waste Management Strategy.
3. The second letter from Minister Rattenbury is in his portfolio capacity as the Minister for Climate Change and Sustainability. It provides analysis from EPSDD that seeks to demonstrate that electricity generated from the incineration of non-biomass waste is more emissions intensive than the current ACT electricity supply. On this basis he states he would not support the generation of electricity from the incineration of waste.
4. ACT NOWaste is drafting responses for you to these two letters.
5. Minister Rattenbury, on behalf of the ACT Greens, has publicly expressed concerns about waste-to-energy, including most recently in Sunday's Canberra Times.
6. [redacted]

**Issues**

ACT Greens Waste Policy Framework

7. The ACT Greens Waste Policy Framework seeks to make a case for banning certain types of waste-to-energy projects in the ACT. It does not suggest a considered view of strategic waste management in the ACT.
8. Among other things the document seeks to displace the existing ACT waste hierarchy with a new waste hierarchy that excludes waste-to-energy. This is a unique perspective on the universally accepted waste hierarchy.
9. The document (on page 3) contains nine key principles:
   - Principle 1 proposes a partial hierarchy that ignores what happens to waste when there is no market for recycling (i.e. it either gets thermally treated or goes to landfill);
   - Principle 2 states that waste should be dealt with at its source by minimising waste generation and increasing source separation. This is feasible in principle but is not always practical;
   - Principle 3 states "minimise the amount of waste that goes to landfill". This is consistent with the ACT Waste Management Strategy. What is inconsistent is claiming the 90% by 2025 landfill diversion target can still be achieved while placing a ban on waste-to-energy. This is something that has not been achieved by any comparable jurisdiction;
   - Principle 4 proposes maximising avoidance, reuses, repair, recycling and composting, which is consistent with the current ACT Waste Management Strategy and considered best practice;

- Principle 5 proposes that the ACT Waste Management Strategy align with the ACT's zero net greenhouse gas emissions target and commitment to the Paris Climate Agreement. This is discussed further below;
- Principle 6 refers to protecting air quality and human health in line with Australia's commitment to the Stockholm Convention on Protecting Human Health and the Environment from Persistent Organic Pollutants. The adoption of waste-to-energy in the ACT, as in the rest of Australia, does not in itself breach Australia's commitment to this convention. Those EU countries with high levels of waste-to-energy, such as Germany, Austria, France, and Denmark, are signatories to the convention;
- Principle 7 prohibits incineration of waste including specific technologies that deploy combustion, gasification, pyrolysis and plasma arc technologies. In other words it seeks to prohibit technologies, many of which are used safely in advanced economies throughout the World, and are not prohibited in any other jurisdiction in Australia;
- Principle 8 states "Support zero waste industry and clean energy innovations that do not rely on thermal destruction of finite resources"; and
- Principle 9 states "Ensure that ACT's waste management contracts do not require or depend on long-term high levels of waste generation to ensure they are financially viable". This is an interesting position and requires further consideration as it raises some complex questions around the type of waste management infrastructure the Territory needs to access in order to manage its waste into the future.

10. Page 4 – seeks to place landfilling above waste-to-energy on the waste hierarchy, which is inconsistent with international best practice and inconsistent with the Parliamentary Agreement which supports ACT waste management achieving national best practice.

11. The document claims the 2025 target of 90% resource recovery is achievable "but cannot be reached if we simply continue on the current path". The ACT Government's commissioning of the WFS in 2015-16 was recognition that a new approach is required and the proposed WFS roadmap provides the best way to move toward a 90% target. The Greens policy fails to acknowledge that no jurisdiction has achieved 90% landfill diversion without waste-to-energy of around 20-30% of total waste diversion.

12. Minister Rattenbury is seeking to engage with you on the *ACT Greens Waste Policy Framework* and canvases the possibility of incorporating its nine principles into the ACT's Waste Management Strategy. This appears premature [redacted] Subject to your agreement TCCS could conduct public consultation as part of [redacted] providing an appropriate avenue for key stakeholders to have input into [redacted]

Minister Rattenbury's letter on the greenhouse gas impacts of ACT waste-to-energy proposals

13. As noted in paragraph 3 above, Minister Rattenbury has written to you at Attachment A about the greenhouse gas impacts of ACT waste-to-energy proposals. EPSDD advice is that [redacted]

14. The current methodology for measuring the net greenhouse gas impact of the ACT waste sector is extremely limited in its scope, and does not provide a true reflection of its actual contribution to global greenhouse gas emissions. This is due to the following net emissions being excluded:
    - avoided emissions arising from recycling substituting for virgin products;
    - emissions generated or avoided outside of the ACT; and
    - emissions from waste-related transport are counted as transport emissions and not waste emissions.

15. The production of PEF for export will also not be counted in the ACT's greenhouse gas inventory because it would be incinerated in cement kilns outside of the ACT, so the emissions are not counted. Similarly emissions from the transport of PEF outside of the ACT are not considered, nor is the benefit from the PEF replacing coal or gas taken into consideration in scope 1 emissions.

16. The WFS recommends the Territory evaluate the production of a PEF to be exported to cement kilns in Australia or South-East Asia to replace gas or coal. The WFS argues this has a positive greenhouse gas impact as it would substitute residual (non-recyclable) waste as the fuel source for coal or gas. Similarly incineration of waste in the ACT to generate electricity into the National Electricity Market cannot be argued to be of no greenhouse gas emissions benefit simply because it does not supply power into the ACT.

EPSDD comments on the WFS Cabinet Submission

17. [redacted]

18. [redacted]

19. [redacted]

Impact on the recommendations in the WFS Cabinet Submission

20. [redacted]

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[1] Biomass waste consists of wood, leaves, grass and other organic waste. Plastic and coal are examples of a non-biomass waste.

[redacted]

21. [redacted]

22. [redacted]

23. [redacted]

Canberra Times article

24. The CT's article reports on a recent statement by Capital Recycling Solutions (CRS) in regard to its waste-to-energy and recycling proposal at Fyshwick, and the *ACT Greens Waste Policy Framework*, which seeks to ban waste incineration in the ACT.

25. The CRS statement (dated 26 October) announced:

- It has split the waste-to-energy proposal into a separate proposal and would take more time to develop this;
- It has reduced the site of the waste-to energy facility from 30 mw to 15 mw, and will not import waste from Sydney as previously proposed;
- It will move forward with its "recycling plans to divert 300,000 tonnes per annum from the Mugga Lane Tip. The waste would be...railed to the Woodlawn Bioreactor"; and
- It will also progress the development of the freight rail terminal on the site enabling the transport of recyclables and other materials by rail.

26. TCCS has briefed you on the CRS proposal see Attachment B including reference to misleading comments by CRS about pressure on landfill capacity at Mugga Lane.

27. On average only 245,000 tonnes of waste per annum has gone to Mugga Lane landfill over the past 5 years, not 300,000 tonnes, and this includes 70,000 tonnes collected by the Territory from households.

28. The [redacted]

29. The Woodlawn Bioreactor is a landfill with an accelerated methane production system. It is not a recycling facility.

30. The CRS proposal without waste-to-energy would only achieve a low level of landfill diversion through its MRF.

**Financial Implications**

31. Nil.

**Benefits/Sensitivities**

32. The WFS Report has taken into consideration a broad range of views from diverse stakeholders. It has a sound policy basis supported by evidence, while being mindful of community concerns around waste-to-energy. The WFS Roadmap acknowledges economic realities and uncertainties that exist in waste management and provides budgetary flexibility in its delivery.

**Media Implications**

33. This matter is attracting media interest.

| | | |
|---|---|---|
| Signatory Name: | Director General, Emma Thomas | Phone: x78658 |
| Action Officer: | Deputy Director-General, Jim Corrigan | Phone: x75819 |

**Attachments**

| Attachment | Title |
|---|---|
| Attachment A | Letters from Minister Rattenbury |
| Attachment B | B17/164 – Capital Recycling Solutions Recycling and Waste-to-Energy Plant |

ACT Government
Transport Canberra and City Services

# DEPUTY DIRECTOR-GENERAL BRIEF

Objective/Trim Reference: DGBR18/130

UNCLASSIFIED

| | |
|---|---|
| **To:** | Jim Corrigan, Deputy Director-General TCCS & Waste Manager |
| **From:** | Michael Trushell, Director, ACT NoWaste |
| **Subject:** | Waste Manager representations to Capital Recycling Solutions draft EIS |
| **Critical Date:** | 16 May 2018 |
| **Critical Reason:** | Environment, Planning and Sustainable Development Directorate have requested that representations on the draft EIS be submitted to the Chief Planning Executive by 16 May 2018. |

**Purpose**

For you, as Waste Manager under the *Waste Management and Resource Recovery Act 2016*, to make representations to the Chief Planning Executive regarding Capital Recycling Solutions draft EIS for a Material Recycling Facility in Fyshwick, ACT.

**Recommendations**

That you:

1. Note the information contained in this brief and Attachment A; and

   **Noted / Please Discuss**

2. Sign the letter at Attachment A making representations to the Chief Planning Executive.

   **Agreed / Not Agreed / Please Discuss**

Jim Corrigan, Deputy Director-General ................................ 16/5/18

| Deputy Director-General's Feedback |
|---|
| |

**Background**

1. Capital Recycling Solutions (CRS) has proposed to construct a Material Recovery Facility (MRF) in Fyshwick, ACT.

2. In accordance with processes under the *Planning and Development Act 2007* (Planning Act), a draft Environmental Impact Statement (EIS) has been developed for the proposal and is open for public comment.

3. The draft EIS outlines a proposal to process waste material originating in the ACT and surrounding region through a MRF, and to separate this material for recycling and disposal. The proposal indicates that inbound materials will be transported by road, with outbound recyclables and residual waste for disposal transported by road and rail.

4. Residual waste is proposed to be transported by rail to the Veolia Woodlawn Bioreactor for disposal.

5. The proposed facility will require a waste facility licence under the *Waste Management and Resource Recovery Act 2016* (Waste Act). Additionally, all businesses transporting waste to and from the facility, by road or rail, will require registration under the Waste Act.

6. Due to recent engagement by the Waste Regulation Team in respect of a licence application for an adjacent facility (operated by a related company), CRS is aware of the requirement for licensing and registration under the Waste Act.

7. Through the abovementioned discussions it is anticipated that CRS will be unlikely to make an application under the Waste Act until there is further progress with the Planning Act processes.

8. Should an application be made by CRS, the application will be assessed in accordance with policies and procedures and is consistent with the requirements of the Waste Act.

9. As compliance with the Waste Act is required in order for CRS's proposal to be viable, it is necessary for a representation by the Waste Manager to be made on the draft EIS.

10. It is recommended that you note the contents of this brief (**Recommendation 1**) and that you sign the letter at <u>Attachment A</u> making representations in regard of the draft EIS (**Recommendation 2**).

11. ACT NoWaste will also make a representation on the draft EIS in regard to the context of the ACT Waste Management Strategy and other relevant matters.

**Issues**

12. CRS previously proposed to use the Fyshwick site for a waste to energy facility (which would also require licensing under the Waste Act in order to operate). The proposal was withdrawn due to community concerns without an application for licensing under the Waste Act being made.

13. Although the draft EIS is for a different type of facility that does not include a Waste to Energy component, media reports suggest a high level of mistrust of CRS's long term

intentions for the site; including a concern that waste to energy will be introduced at a later stage.

**Financial Implications**

14. Nil

**Consultation**

Internal

15. Nil

Cross Directorate

16. EPSDD in respect of procedures for the draft EIS.

External

17. Nil

**Benefits/Sensitivities**

18. It is important that a representation to the draft EIS is made by the Waste Manager, as Statutory Authority under the Waste Act. In doing so, the Waste Manager calls attention to the requirements of the Waste Act for CDS, as well as for other proponents who may be undertaking, or proposing to undertake, waste management activities in the ACT.

19. [redacted]

**Media Implications**

20. The proposal is the subject of media attention in The *Canberra Times*, and has been the focus of social media campaigns by community groups.

Michael Trushell
Director, ACT NoWaste
15 May 2018

Phone: 6207 2840

Action Officer: Alex Taylor
Manager, Waste Regulation

Phone: 6207 3468

**Attachment A:** *Representations from the Waste Manager*

167(A)

ACT
Government

Transport Canberra
and City Services

Mr Ben Ponton
Chief Planning Executive
Environment, Planning and Sustainable Development Directorate
GPO Box 158
Canberra ACT 2601

Dear Mr Ponton Ben

**Materials Recovery Facility – Fyshwick – EIS Application 201700053**

I write to make representations regarding draft Environmental Impact Statement (EIS) application 201700053; the proposal by Capital Recycling Solutions Pty Ltd (CRS) to develop a Materials Recovery Facility in Fyshwick, ACT.

On 1 July 2017, the *Waste Management and Resource Recovery Act 2016* (Waste Act) came into effect in the Australian Capital Territory, providing a regulatory framework to support initiatives and interventions under the *ACT Waste Management Strategy* and *Waste Feasibility Study.*

The objects of the Waste Act are to minimise landfilling, maximise resource reuse and recovery, and to encourage investment, innovation and best practice in the waste industry. Under the Waste Act, all waste facilities, irrespective of size, are required to hold a licence in order to operate. Similarly, all businesses moving waste into, out of and within, the ACT are required to be registered as a waste transporter.

Businesses operating without a licence and/or registration may be subject to penalties of up to $375,000; Executive Officers may also be subject to criminal prosecution.

As a waste management business proposing to operate a waste facility in the ACT, CRS must obtain a licence under the Waste Act. To enable an efficient assessment process, CRS should make an application at a time when there is certainty over planning approval, and there is clarity of how the proposed facility will operate.

Any business transporting waste to and from the proposed facility, whether by road or rail, must hold a waste transporter registration. Applications for registration as a waste transporter can be made at any time, however that business cannot transport any waste in the ACT until registration has been approved.

MINISTERIAL BRIEF

**Transport Canberra and City Services**

UNCLASSIFIED

| | | |
|---|---|---|
| **To:** | Minister for Transport and City Services | Tracking No.: B18/196 |
| **From:** | Director General, Transport Canberra and City Services | |
| **Subject:** | Waste-to-Energy (WtoE) policy in the ACT – forward plan | |
| **Critical Date:** | In the normal course of business | |

**Purpose**

To seek your agreement to the forward plan for developing a Waste-to-Energy (WtoE) Policy in the ACT following the Waste Feasibility Study 2018, including the preparation of a Cabinet Submission seeking agreement to consult with the community.

**Recommendations**

That you:

1. note the information contained in this brief, including the project plan at Attachment A;

   **Noted / Please Discuss**

2. agree to the establishment of a cross-Directorate working group to develop a discussion paper and stakeholder engagement plan; and

   **Agreed / Not Agreed / Please Discuss**

3. agree to the preparation of a Cabinet Submission to consult with the community on the discussion paper and develop a policy position.

   **Agreed / Not Agreed / Please Discuss**

Meegan Fitzharris MLA ........................................ 12/6/18

Minister's Office Feedback

[redacted]

UNCLASSIFIED

**Background**

1. The ACT Government is committed to improving the Territory's performance in waste management. This is reflected in the ACT Waste Management Strategy—Towards a Sustainable Canberra 2011-2025 (the Strategy) at Attachment B.

2. The goal of the Strategy is to ensure that the ACT leads innovation to achieve full resource recovery and a carbon neutral waste sector. It also sets an ambitious goal of 90% resource recovery by 2025.

3. The ACT currently generates about one million tonnes of waste per year. The current resource recovery rate has plateaued at around 70 per cent for the last decade, with an average of about 250,000 to 300,000 tonnes of waste each year going straight to landfill.

4. The 2018 Waste Feasibility Study was commissioned by Government to identify possible pathways (a roadmap) to achieve the ambitious goals set out in the Strategy, including driving towards 90% resource recovery.

5. The Waste Feasibility Study Roadmap and a Discussion Paper (Attachment C) is currently out for public consultation until 18 June 2018.

6. A key recommendation of the Waste Feasibility Study is the development of a Waste-to-Energy (WtoE) policy. The Study also makes it clear that the ACT will be unlikely to meet its target of 90% resource recovery, or move beyond 80% resource recovery, without some form of WtoE.

7. The 2011 Strategy envisaged consideration of waste-to-energy technologies when it was released. It set a target of doubling the energy generated from waste in the ACT by 2020, and to consider expanding bioenergy generation and investigating new WtoE technologies. The Strategy found that 10–20% of the ACT's waste streams could be better utilised for energy generation and could be a competitive form of renewable energy in the ACT, with WtoE generating a number of positive outcomes including:

   a. increased resource recovery;

   b. reduced requirements for additional landfill;

   c. reduced greenhouse gas emissions;

   d. production of renewable energy; and

   e. potentially sequestering carbon through biochar manufacture.

8. Biochar has been described as 'a uniquely powerful solution [that allows] us to address food security, the fuel crisis, and the climate problem, and all in an immensely practical manner' (Professor Tim Flannery). More information on biochar is in the project overview at Attachment D.

9. The ACT community has become increasingly aware of WtoE over the last 12 months, driven in part by media interest in waste and two high-profile WtoE proposals (the Foy proposal in Hume and the CRS proposal in Fyshwick). The Foy proposal resulted in an Independent Inquiry Panel being established by the Minister for the Environment following an environmental impact assessment (EIS) process. The Panel recommended against the proposal on the grounds of unknown impacts, due to the poor quality of information provided and the potential for health and environmental consequences.

10. Concerns have been raised regarding the perceived potential for pollution from WtoE, and use of technologies that may disregard the waste hierarchy. There has also been a call in the community for the ACT Government to adopt the NSW WtoE policy. This policy is currently under review following a NSW Parliamentary Inquiry into WtoE.

11. Although adopting WtoE is an option that sits just before landfilling in the waste hierarchy, it represents a significant proportion of resource recovery globally with a large number of plants operating in Europe and Asia. Where implemented appropriately and safely, it can be an important tool to prevent waste ending up in landfill whilst also producing renewable energy.

12. The waste industry has expressed significant interest in the possibility of implementing WtoE technologies in the ACT. The industry has also expressed an expectation of policy and regulatory certainty to promote and support WtoE (or otherwise).

13. At an Australian meeting of Environment Ministers on 27 April 2018 it was agreed, at a national level, to explore WtoE further. There is no national framework for WtoE and jurisdictions across Australia have established their own frameworks, or are looking at establishing frameworks.

14. The Federal Government is generally supportive of WtoE and has provided finance and grant funding to a number of new WtoE projects in Australia through the Clean Energy Finance Corporation and Sustainable Cities Investment Program. Some jurisdictions in Australia, such as South Australia, also encourage and provide grant funding for WtoE projects (for example, processed engineered fuel).

15. The ACT Greens have a strong policy position on WtoE, set out in their policy statement A Sustainable Zero Waste Future (Attachment E). They do not support thermal WtoE in the ACT, and in particular any form of burning or incineration of waste.

16. WtoE already occurs in the ACT. Currently, energy is generated from methane gas capture at the Mugga Lane and West Belconnen landfill facilities, which powers around 3,000 homes. The ACT has also used thermal processing to manage sewage sludge since the 1970's, medical wastes since the 1980's and wood waste since 2015.

17. While the burning or heating (thermal treatment) of waste is contentious in the community, it has been occurring around the world (particularly in Europe) for many years. Some of this technology is tried and tested with a clear understanding of health and environmental impacts, and other technologies are new and have not yet been tested at a large scale or at multiple sites.

18. Not all methods of WtoE involve burning or even heating, for example pyrolysis which can result in biochar uses a heating process in the absence of oxygen (no burning) while anaerobic digestion uses no heating at all, and is in effect an advanced form of composting.

19. Other methods; such as processed engineered fuel (PEF), involve a manufacturing process without heat (e.g. shredding) that feeds into a WtoE plant. The PEF itself is burnt through other processes (e.g. the cement making process). An option favourably presented in the Waste Feasibility Study is the manufacturing of PEF within the ACT, without heating or burning occurring, for transport to other facilities for burning. It would mean that fuels, such as gas, which are already used in processes such as cement making could be replaced with bioenergy from PEF. An example is provided in the project overview at Attachment D.

**Issues**

20. WtoE has been the subject of significant community debate and concern in the ACT.

21. The community and industry are calling for certainty and a clear position about what Government and the community expect and allow when it comes to WtoE in the ACT.

22. In the absence of a clear policy or regulatory position, proposals [redacted] in Hume and [redacted] in Fyshwick will continue to be submitted without a clear understanding of community and Government levels of acceptance and tolerance.

23. It has been identified that the ACT needs a long term, informed and evidence based policy vision for WtoE that provides certainty for the community and industry. The scope and an overview of this project, including possible high-level options that have been identified at this early stage, is at Attachment D.

24. Developing a WtoE policy will involve extensive community education, deliberation and consultation to determine whether WtoE has a role in the future vision for resource recovery and renewable energy in the Nation's Capital.

25. It has been well recognised that the community is the number one stakeholder when it comes to WtoE projects and developing a WtoE policy, which was highlighted during the recent NSW Parliamentary Inquiry into WtoE. Therefore, it is important that any policy is co-designed with the community and key stakeholders.

26. A project plan (Attachment A) has been developed outlining proposed next steps for progressing a WtoE policy in the ACT, including seeking Cabinet agreement prior to any community consultation. In summary, these steps are:

    a. [redacted]

    b. [redacted]

c. [redacted]

d. [redacted]

e. [redacted]

f. [redacted].

27. It is recommended that you note the project plan (Attachment A) and project overview (Attachment D) and agree to the preparation of a Cabinet Submission.

**Financial Implications**

28. No financial implications associated with this Brief.

**Consultation**

Cross Directorate

29. [redacted].

30. [redacted].

External

31. [redacted].

32. [redacted].

**Benefits/Sensitivities**

33. WtoE is a sensitive and contentious topic within the community.

34. WtoE is complex and involves a variety of different technologies and processes, some of which are already occurring in the ACT.

35. The ACT Greens have a strong policy position against WtoE, and in particular incineration or burning.

**Media Implications**

36. There are no media implications associated with this Brief. A communications strategy will be developed to accompany the Cabinet Submission, if agreed to by the Minister.

06/06/18

| | | | |
|---|---|---|---|
| Signatory Name: | Emma Thomas | Phone: | X78658 |
| Action Officer: | Jim Corrigan | Phone: | X75819 |

**Attachments**

| Attachment | Title |
|---|---|
| Attachment A | Project Plan |
| Attachment B | ACT Waste Management Strategy – Towards a Sustainable Canberra 2011-2025 |
| Attachment C | Waste Feasibility Study Roadmap and a Discussion Paper |
| Attachment D | Project overview – power point presentation |
| Attachment E | A Sustainable Zero Waste Future – ACT Greens |

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SENSITIVE: CABINET

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