Waste Management in the Modern World: Practices and Issues

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- Casual Academic, UNSW
- Civil engineer (UTS 1988)
- PhD (Biofiltration of Landfill Gas) (UNSW 2009)
- >25 years experience as a consulting / project engineer:
  - Waste management (planning, landfilling, waste processing)
  - Wastewater (landfill leachate, sewage)
  - Stormwater
  - Government (Federal, State, Local)
  - Industry (waste management companies)
  - International (Development Projects)
Waste Management in the Modern World

Outline:

• Brief history of waste management in Sydney
• Current strategies and practices
• The Future
• How are we going (performing)?
• Landfill waste disposal
• Kimbriki Resource Recovery Centre
Terminology!!!!
The Distant Past

Pre 1930s:

- On site management e.g. burial, burning / incineration, composting
- Suburban / local “tips” or “dumps”
- Dumping at sea (>5 miles and then 15 miles off the coast)
- Incineration

Source: https://scratchingsydneyssurface.wordpress.com/2011/08/06/5-august-2011-a-load-of-rubbish/
The Distant Past

1930 – 1950s:

• On site management e.g. burial, burning / incineration, composting
• Suburban / local “tips”
• Refuse “destructors”
• Griffin incinerators (Glebe, Willoughby, Pyrmont, Randwick)
• Other incinerators (Mosman, Manly, and many others)
Now

Incinerator Café (Willoughby):

The Past

1950 / 60s:

• Suburban tips everywhere (> 100 across Sydney!!!)
• Operated by local government
• Overseen by Department of Public Health
• No / little waste compaction or covering
• No leachate management
• Fires were common and often deliberate
• “Festering heaps of garbage that has been uncovered for days”
• “Hazard to health and the environment”

Source: Good Riddance, A history of waste management in Manly, Mosman, Pittwater and Warringah, Curby & Macleod, 2003
The Past

1950 / 60s (cont’d):

Source: Good Riddance, A history of waste management in Manly, Mosman, Pittwater and Warringah, Curby & Macleod, 2003
The Past

1950/60s (cont’d):

and large areas have been treated in this way close to beaches without objection. The completed areas are and will provide valuable public recreation areas … method is 10/6 per ton which is higher than the County but the high standard of tip operation and the difference."

Careel Bay tip, January 1967. This supposedly 'dry rubbish' tip where putrescible waste was also sometimes dumped opened in 1959. On the day that waste investigator A. E. Barton visited in 1970, he noted that 'swamp land' was being reclaimed and that 'the bulldozer was pushing garbage into water'. This could, he concluded in the underestimation of the year, 'will cause pollution'. Although the Department of Public Health, one of whose inspectors took this photo, threatened to close the tip down, nothing was done about it.

Courtesy of Warringah Council

Source: Good Riddance, A history of waste management in Manly, Mosman, Pittwater and Warringah, Curby & Macleod, 2003
The Past

1970 / 80s:

- Barton review of liquid and solid waste management (1970)
- First Sydney (regional) waste disposal (30 year) plan (1972) – consolidate 70 landfills to 10 landfills
- Move to sanitary landfilling with improved stormwater and leachate management
The Past

1970 / 80s (cont’d):

- MWDA developed a network of waste transfer stations (4) and basic sanitary landfills (8 regional depots).
- Waverly Woollahra incinerator commences operation (1975)
- 90% of waste landfilled 10% incinerated
Recent Past

1990s (Decade of change):

- MWDA morphed into Waste Management Authority (WMA) – focus broadened to include recycling
- 20 year waste management strategy for Sydney (1992)
- NSW EPA is formed and takes over regulation of waste activities
- Recycling (starts in earnest).
- Back yard burning of garden waste banned!!!!
- First engineered sanitary landfills in NSW (Elizabeth Drive Landfill, Summerhill WMF, Whytes Gully Landfill)
- WMA corporatised (WRPS and then Waste Service NSW)
- Private sector enters solid waste disposal business

Waste Crisis

No time to Waste
Recent Past

1990s (cont’d):

• Closure and rehabilitation of old “tips” (commences in earnest)
• Waverly Woollahra incinerator closes (1996)
• Regional waste management boards established (7) and undertook planning (mid 1990s) – to reduce waste to landfill by 60% by 2000
• Waste levy on waste disposed to landfill increased – to fund and encourage waste minimisation and recycling ($10 / tonne)
• First MRFs developed for mixed domestic recyclable materials (mid-1990s)
• First AWTs developed (late 1990s) (Bedminster, Port Stephens)
Recent Past

2000 – 2010:

• Integrated infrastructure plan (for Sydney)
• Regional waste boards dissolved (did not achieve 60% diversion???)
• Waste Avoidance and Resource Recovery Act, 2001
• Resource NSW formed
• Lucas Heights WMC (Landfill) expansion approved
• Waste Avoidance and Resource Recovery (WARR) Strategy 2003
• Revised WARR strategy 2007
• Eastern Creek WMC Stage 2 (Landfill) approved
• Waste (landfill) levy progressively increased, significantly (from $10/t to $85/t)
Recent Past

2000 – 2010 (cont’d):

- Various materials / energy recovery facilities developed (UR3R, Jacks Gully, Port Macquarie, Coffs Harbour)
- Engineered sanitary landfills – becoming more sophisticated e.g. bioreactor landfill (Woodlawn)
Current Strategies and Practices

2010 to date:

• Government exited waste management business (WSN and infrastructure sold to private sector (SUEZ)) 2011
• RR Infrastructure needs analysis (GHD / EPA) 2011
• Woodlawn “Bioreactor” approved to receive up to 1.1 million t/yr
• Dial-a-Dump (DIAD) Genesis facility (integrated resource recovery & landfill facility – up to 2.0 million t/yr)
Current Strategies and Practices

2010 to date:

• Waste Less Recycle More Funding program (2013) (5 year, $465 million investment program):
  – Waste and resource recovery initiative
  – $465 million “splurge” over 5 years
  – Funded by the Waste Levy
  – 6 target areas:
    • Waste and recycling infrastructure package ($250 million)
    • Local government program ($137.7 million) (to support local communities)
    • Illegal dumping program ($58 million)
    • Litter program ($20 million)
    • Improvements to the waste levy
    • Energy recovery (policy)
2010 to date:

• New WARR Strategy 2014-21 (Dec 2014):
  • Policy / vision:
    – “to enable all of the NSW community to improve environment and community well-being by reducing the environmental impact of waste and using resources more efficiently”
    – “using resources efficiently and keeping materials circulating in the productive economy can also help to create jobs and grow the NSW economy”
Current Strategies and Practices

2010 to date:

  - Guiding principle: Waste management hierarchy

![Waste Hierarchy Diagram](image)

Figure 2: The waste hierarchy
Current Strategies and Practices

2010 to date:

• WARR Strategy 2014-21 (Dec 2014):
  – Six (6) key targeted areas:
    • Avoiding and reduce waste generation
    • Increased recycling
    • Divert more waste from landfill
    • Manage problem wastes better
    • Reduce litter
    • Reduce illegal dumping
Current Strategies and Practices

2010 to date:

• WARR Strategy 2014-21 (Dec 2014):
  – **Avoiding and reduce waste generation:**
  – **Target:**
    • by 2021-22 reduce the rate of waste generation per capita
  – **How:**
    • Economic incentives (Waste Levy)
    • Behaviour change
    • Product stewardship
    • Industrial ecology
Current Strategies and Practices

2010 to date:
• WARR Strategy 2014-21 (Dec 2014):
  – Increased recycling:
  – Target: by 2021 increase recycling rates for:
    • Municipal solid waste (from 52% to 70%)
    • Commercial and industrial waste (from 57% to 70%)
    • Construction and demolition waste (from 75% to 80%)
  – How:
    • Increase effectiveness of kerbside recycling
    • Target food and garden waste
    • Invest in infrastructure for C&I recycling
    • Remove problem wastes
    • Develop markets and encourage innovation
    • Build capacity for developing regional recycling plans
Current Strategies and Practices

2010 to date:

• WARR Strategy 2014-21 (Dec 2014):
  – **Divert more waste from landfill:**
  – **Target:**
    • by 2021, increase diversion of waste from landfill from **63% to 75%**
  – **How:**
    • Reduce waste generation
    • Increased recycling
    • Economic incentives (increased Waste Levy)
Current Strategies and Practices

2010 to date:

  - **Measuring Progress:**
    - Evaluated and reported every 2 years
    - Progress in each target area assessed:
      - Waste generation (quantity)
      - Recycling (range and quantity)
      - Waste to landfill (quantity)
      - Problem waste collected (range and quantity)
      - Litter (surveys)
      - Illegal dumping (No. and scale)
Current Strategies and Practices

2010 to date:

• Waste (landfill) levy 2016-17:
  – Metro: $135.70 / tonne
  – Reg: $78.20 / tonne

Kimbriki charges (2016/17):

• Mixed waste (to landfill): $330/t
• Recyclable material: No charge (steel, cardboard, bottles and cans)
• Concrete: $20/t
• Mixed concrete and brick: $25/t
• Vegetation: $195/t
Current Strategies and Practices

2010 to date:

• Energy from Waste Policy (2014):
  – The recovery of energy and resources from the thermal processing of waste has the potential, as part of an integrated waste management strategy, to deliver positive outcomes for the community and the environment”
  – “Energy from waste can be a valid pathway for residual waste where:
    • Further material recovery is not financially sustainable or technically achievable
    • Community acceptance to operate such a facility has been obtained”
2010 to date:

- Energy from Waste Policy (2014):
  - Eligible waste fuels (current) include:
    - Biomass from agriculture
    - Forestry and saw milling residues
    - Uncontaminated wood waste
    - Recovered waste oil
    - Organic residues from virgin paper pulping
    - Landfill gas and biogas
    - Source separated green waste (used in processes that produce a char)
    - Tyres (used in approved cement kilns)
Current Strategies and Practices

2010 to date:

- Energy from Waste Policy (2014):
  - Excludes the following:
    - Incineration facilities for the destruction of waste
    - Facilities for the thermal treatment of contaminated soil
    - Facilities proposing the **thermal treatment of unprocessed mixed waste streams**
    - Facilities proposing the **thermal treatment of waste that has been exhumed from landfills**
    - Facilities proposing the thermal treatment of hazardous waste materials
The Future?

Waste Strategy goals:
- Avoid and reduce waste generation
- Increase recycling and resource recovery
- Reduce landfill waste disposal

Goals / Target areas:
- Food & garden waste (domestic and commercial)
- Increased recovery of recyclables (domestic and commercial)

The Plan??
The Future?

SUEZ (formerly SITA):

- Upgrading the Lucas Heights Resource Recovery Park (Suez):
  - New garden organics processing facility (upgraded and enlarged) (80,000 t/yr)
  - Advanced Resource Recovery Technology (ARRT) facility (MBT with organics recovery) (up to 200,000 t/yr with a claimed 70% recovery)
  - Increased landfill capacity (8.3 million m³)
The Future?

Veolia:

- Banksmeadow waste transfer facility (road/rail) (400,000 t/yr)
- Camelia Recycling Centre (Dirty MRF) (200,000 t/yr non-putrescible solid waste)
- Woodlawn MBT (200,000 t/yr). Organics to be used to rehabilitate the mine site.
The Future?

DIAD:
• Next Generation Energy from Waste Facility
  (thermal WtE facility – 140MW)
  (up to 1.0 million t/yr)

Cleanaway (TPI):
• ???

Remondis:
• ???

ResourceCo:
• Wetherill Park PEF facility
  (250,000t/yr) (Dirty MRF)
  (claimed 90% recovery)
Kimbriki:
• Landfill Resource Recovery Facility (LRRF) (Dirty MRF) (60,000 t/yr)
• Resource Recovery Facility (RRF) (ORF + MBT) (100,000 t/yr)  
  (Source separated organics and residual waste)
• Materials Recovery Facility (MRF) (mixed recyclables) (35,000 t/yr)
The Future?

ANL:

• FOGO Infrastructure Project (Food & Garden Organics)
• Located and Badgerys Creek and Blayney
• 50,000 t/yr
The Future?

Other:
• Future landfills?
• Additional waste transfer stations?
• Additional MRFs (for mixed recyclables)?

Waiting outcome of Updated Infrastructure Needs Analysis???
Integrated Waste Management Plan

• Assessment of waste generation (current and future)
• Evaluation of existing practices and systems
• Identifies goals and actions to achieve the goals:
  – All waste streams (MSW, C&I, C&D)
  – Waste avoidance / minimisation, recycling & resource recovery
  – Waste collection and transfer
  – Residual waste management
  – Short term (1 to 3 year timeframe)
  – Longer term (> 5 years and up to 20 years)
• Costs and funding
• Responsibilities
• Program / timing
• Community education
• Monitoring and evaluation
• Reporting
Other Issues and Challenges

- Developing waste management infrastructure is complex, costly, takes a long time, and fraught with uncertainty (particularly approvals)

- Compliance with the new EfW Policy and Waste Management Hierarchy

- Securing waste supply (feed stock)

- Markets for recovered materials ($$$$$, volatility, local / over seas)
Performance

How are we going in relation to avoiding / reducing waste generation?

Figure 7.2: Waste disposed and recycled by waste stream for NSW, 2002–03 to 2012–13

Source: EPA data 2015
Notes: C&D = construction and demolition. C&I = commercial and industrial.

Performance?

How are we going in relation to *avoiding / reducing* waste generation?

Source: NSW EPA
State of Environment Report 2015

Figure 7.1: Per person waste recycled, disposed and generated

Source: EPA data 2015
Note: MLA = Metropolitan Levy Area.
Performance?

How are we going in relation to recycling?

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Municipal</td>
<td>31%</td>
<td>33%</td>
<td>38%</td>
<td>44%</td>
<td>52%</td>
<td>55%</td>
<td>66%</td>
</tr>
<tr>
<td>C&amp;I</td>
<td>34%</td>
<td>38%</td>
<td>44%</td>
<td>52%</td>
<td>57%</td>
<td>61%</td>
<td>63%</td>
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<tr>
<td>C&amp;D</td>
<td>64%</td>
<td>62%</td>
<td>67%</td>
<td>73%</td>
<td>75%</td>
<td>69%</td>
<td>76%</td>
</tr>
</tbody>
</table>

Source: EPA data 2015


Target

2021

70%
70%
80%

Performance?

How are we going in relation to reducing landfill waste disposal?

Figure 7.2: Waste disposed and recycled by waste stream for NSW, 2002–03 to 2012–13


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Performance?

How are we going in relation to avoiding / reducing waste generation?

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Performance?

How are we going in relation to avoiding / reducing waste generation?

Source: NSW EPA
State of Environment Report 2015

Source: EPA data 2015
Note: MLA = Metropolitan Levy Area.
Performance?

How is the rest of Australia doing?

Source: Blue Environment 2013

Figure E1: Australia by jurisdiction 2010/11 (a) per capita and (b) total waste generated by management including resource recovery rate (excluding fly ash)

(a)
Performance?

Figure 4.2 Physical flow of waste in Australia, 2009-10

Households – 12.4m tonnes
Construction – 16.5m tonnes
Services – 11.9m tonnes
Manufacturing – 8.5m tonnes
Other – 3.8m tonnes
Imports – 0.6m tonnes

Waste generated and imports 53.7 million tonnes

Waste treatment

Disposal
- Waste Mgmt Industry 18.3m tonnes
- Other industries 6.5m tonnes

Recovery
- Waste Mgmt Industry 13.7m tonnes
- Other industries 11.6m tonnes

Exports – 3.7m tonnes

Landfill 24.9 million tonnes

Source: WAAEE (ABS cat. no. 4602.0.55.005)

Source: ABS 2013
Performance?

How do we compare globally?

<table>
<thead>
<tr>
<th>Income Level</th>
<th>Number of Countries Included</th>
<th>Total Urban Population (millions)</th>
<th>Urban MSW Generation</th>
<th>Projected Population</th>
<th>Projected Urban MSW Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Per Capita (kg/capita/day)</td>
<td>Total (tonnes/day)</td>
<td>Per Capita (kg/capita/day)</td>
</tr>
<tr>
<td>Lower Income</td>
<td>38</td>
<td>343</td>
<td>0.60</td>
<td>204,802</td>
<td>1,637</td>
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<tr>
<td>Lower Middle Income</td>
<td>42</td>
<td>1,293</td>
<td>0.78</td>
<td>1,012,321</td>
<td>4,011</td>
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<tr>
<td>Upper Middle Income</td>
<td>35</td>
<td>572</td>
<td>1.16</td>
<td>665,586</td>
<td>888</td>
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<tr>
<td>High Income</td>
<td>46</td>
<td>774</td>
<td>2.13</td>
<td>1,649,546</td>
<td>1,112</td>
</tr>
<tr>
<td>Total</td>
<td>161</td>
<td>2,982</td>
<td>1.19</td>
<td>3,532,255</td>
<td>7,648</td>
</tr>
</tbody>
</table>

Australia: 2.2 kg/cap/day (MSW). 5.7 kg/cap/day (total)

Source: World Bank 2009
Performance?

Waste generation v GDP:

GDP and municipal waste generation in 13 OECD Countries

Figure 1 - Source: The Economist country factsheets, 2008; OECD Factbook 2008
Issue

• Waste generation has increased significantly over the years
• In total and on a per capita basis

• Waste generation is strongly linked to economic activity / growth
• Focus (obsession) on economic growth will lead to increased consumption of resources and consequently waste generation

• Managing the waste is not the issue

• Running out of resources is the issue !!
Other Issues and Challenges

- Avoiding and reducing waste generation
- Changing community behaviour
- Flexible plastic packaging and soiled paper and cardboard
- Recycling complex mixed material products e.g. phones, computers
- Public place recycling
Landfill Waste Disposal

- Landfills are often portrayed as evil!!!

- Landfills have improved dramatically over the past 20 years

- Landfills are currently essential for the disposal of residual waste

- And will remain so for some years
Landfill Waste Disposal

Modern, engineered waste management facility:
- Effective site management
- Comprehensive management & operation plan
- Comprehensive education & training of staff
- Waste minimisation and recycling facilities
- Highly controlled landfilling operation
- Regular / continuous compaction and covering of landfilled waste
Landfill Waste Disposal

Modern engineered waste management facility:

Progressive landfilling and site rehabilitation
Landfill Waste Disposal

Modern engineered waste management facility:

Advanced Leachate Management
Landfill Waste Disposal

Modern engineered waste management facility:

Comprehensive landfill gas management
Landfill Waste Disposal

Modern engineered waste management facility:

Effective
Stormwater
Management
Landfill Waste Disposal

Modern engineered waste management centre:

Comprehensive environmental monitoring, management and reporting
Landfill Waste Disposal

Environmental guidelines: Solid Waste Landfills (2016):

• Provide guidance for the environmental management of landfills in NSW by specifying a series of ‘Minimum Standards’

• Involve a mix of design and construction techniques, effective site operations, monitoring and reporting protocols, and post-closure management

• Apply to general solid waste and restricted solid waste landfills
Landfill Waste Disposal

Environmental guidelines: Solid Waste Landfills (2016):

Broad goals:

• Landfills should be sited, designed, constructed and operated to cause minimum impacts to the environment, human health and amenity

• The waste mass should be stabilised, the site progressively rehabilitated, and the land returned to productive use as soon as practicable

• Wherever feasible, resources should be extracted from the waste and beneficially re-used
Landfill Waste Disposal

Environmental guidelines: Solid Waste Landfills (2016):

Broad goals:

• Adequate data and other information should be available about any impacts from the site, and remedial strategies should be put in place when necessary

• All stakeholders should have confidence that appropriately qualified and experienced personnel are involved in the planning, design and construction of landfills to high standards
Landfill Waste Disposal

Environmental guidelines: Solid Waste Landfills (2016):
Minimum Standards:
• Leachate barrier system
• Leachate storage and disposal
• Stormwater management
• Water quality monitoring
• Landfill gas management and monitoring
• Amenity issues (odour, dust, noise, litter and fire control)
• Waste acceptance and site security
• Covering of waste
• Final capping and revegetation
• Closure
• Quality assurance
Landfill Waste Disposal

Environmental guidelines: Solid Waste Landfills (2016):
Minimum Standards:

- **Leachate barrier system**
- Leachate storage and disposal
- Stormwater management
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- **Landfill gas management and monitoring**
- Amenity issues (odour, dust, noise, litter and fire control)
- Waste acceptance and site security
- Covering of waste
- Final capping and revegetation
- Closure
- **Quality assurance**
The Kimbriki Resource Recovery Centre
The Kimbriki Resource Recovery Centre

Existing Operations
1. Site Office & Carpark
2. Entrance Gatehouse & Weighbridge
3. Recycling Aggregation Area
4. Household Recycling Drop Off
5. Ecohouse & Garden
6. Garden & Wood Waste Recycling Area
7. Electronic Waste Recycling
8. Buy Back Centre & Timber Yard
9. Construction & Demolition Recycling Area
10. Landfill Gas Flare
11. Sandstone Boulders
12. Waste Reception Area
13. Metal Recycling Area
14. Landfill
15. Exit Weighbridge
The Kimbriki Resource Recovery Centre

- Landfilled
- Recovered

Tonnage over time from 1974 to 2014.
The Kimbriki Resource Recovery Centre

Masterplan:
• Developed over 4 years: 2010 – 2014
• Goals:
  – To develop and operate the KRRC as a long term regional resource recovery and waste management facility, with a focus on maximising resource recovery
  – Develop and operate the RRC in a financially, environmentally and socially responsible and sustainable manner, in consultation with the community, the land owner (Northern Beached Council), shareholders, employees and all relevant regulatory agencies
The Kimbriki Resource Recovery Facility

Masterplan:

- Additional resource recovery facilities:
  - Landfill resource recovery facility (50,000 t/yr) (Dirty MRF)
  - Food and garden organics recovery (composting) facility (~45,000 t/yr)
  - Residual waste processing and stabilisation facility (MBT) (~50,000 t/yr)
  - Materials recycling facility (MRF) (for mixed recyclables)
The Kimbriki Resource Recovery Facility

Masterplan:

• Upgrading the landfilling operation:
  – New lined landfill cells (composite lining system)
  – Upgrade landfill gas management to reduce emissions (gas extraction and flaring system, biocovers)
  – Upgrade leachate management system (lined dam, treatment plant, discharge to sewer)
  – Upgrade stormwater management measures
  – On site transfer operation (to active cell)
  – Change landfilling operations to optimise landfill airspace utilisation
Once Masterplan is fully implemented:

The Kimbriki Resource Recovery Facility

> 80% recovery
Concluding Comments

- Waste management in Sydney / NSW has changed dramatically over the last 50+ years
- No longer is it simply dumping garbage (on some unoccupied land or at sea!!)

Flow of waste materials in the 1930s
Concluding Comments

- Waste management is now (2016) much more complex:
Concluding Comments

• Waste generation has increased significantly over the last 50 years

• Waste generation is strongly linked to economic activity / growth

•Whilst we focus on economic growth, resource consumption and waste generation is likely to (will) continue to increase.

• Is this sustainable????
Concluding Comments

Materials flow / sustainable resource consumption

Current materials flow:

Source: Heijo Scharff, 2011
Concluding Comments

Materials flow / sustainable resource consumption


Figure 2: Sankey diagram of material flows through the global economy (world) and the EU-27 in 2005. Numbers show the size of flows in Gt/yr. For a definition of flows, see the article text. EU = European Union; EoL waste = end-of-life waste; Gt/yr = gigatonnes per year; RoW = rest of the world.
Concluding Comments

Materials flow / sustainable resource consumption

Desired materials flow – Sustainable???

Source: Heijo Scharff, 2011
Concluding Comments

Waste flow in Australia

Source: ABS 2013
Questions / Discussion?

Thank you for your attention

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