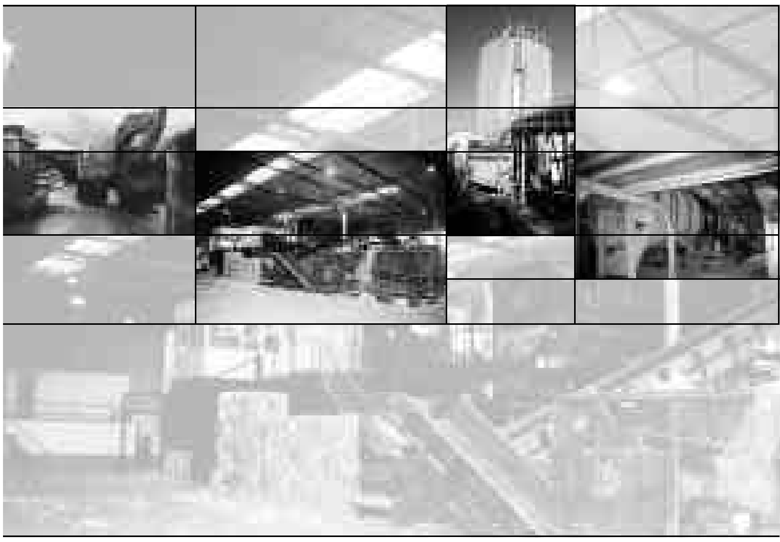

Report of the **Alternative Waste Management Technologies and Practices** Inquiry

APRIL 2000

Disclaimer
This report was prepared by the Alternative Waste Management Technologies and Practices Inquiry for the State Government of New South Wales. The views expressed in the report are those of the indepependant Inquiry.

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WASTE INQUIRY

ALTERNATIVE WASTE MANAGEMENT TECHNOLOGIES AND PRACTICES INQUIRY

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14 April 2000

The Hon. R. Debus MP
Minister for the Environment
Level 25
59-61 Goulburn Street
SYDNEY NSW 2000

Dear Minister,

I enclose a copy of the Report of the Alternative Waste Management Technologies Inquiry, which you established in August 1999.

The availability of technologies, together with strong community support for waste reduction make the next five years a time of great opportunity for further waste management reform.

On behalf of the Waste Inquiry Panel, I hope this report will be helpful to the Government in further shaping strategic policy for waste management in New South Wales.

Yours sincerely,

A.G. Wright
Chairman

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The Inquiry, and particularly the Chair, also greatly benefited from the able assistance of Judy Myers. As the Secretariat she provided excellent and patient support and assistance.

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Executive Summary

Why do some communities manage waste with alacrity while others seem overwhelmed by the task? Are some communities wise in seeking value from waste, or should they choose least-cost disposal options? The Waste Inquiry has sought to understand the potential contribution of waste management practices and technologies in seeking answers to these fundamental questions.

Waste is both diffuse and heterogeneous. It is difficult to handle and often complex to recover for beneficial uses. Many communities, however, now think of waste materials as potential resources, and they invest in systems and infrastructure to capture the benefits waste can bring. New technologies and management practices have been developed over the last ten years to meet the demands of this modern regard for waste.

The New South Wales community too has signalled a strong commitment to sustainable waste management. And the New South Wales Government, through the Minister for the Environment, established the Alternative Waste Management Technologies and Practices Inquiry (Waste Inquiry) in August 1999.

1. Purpose and Background

This report presents the outcomes of the Waste Inquiry. It comprises a review of conventional and emerging waste technologies and the management practices that drive the logistics and transformation of discarded materials to beneficial resources. In accordance with the Terms of Reference, the review has been framed on an ecologically sustainable development basis, emphasising economic, social and environmental dimensions. Technology viability also is a critical consideration.

The intent of the Government in establishing the Waste Inquiry was to inform decisions about future waste management infrastructure and practices in New South Wales. The Report will also provide input to a planned strategic policy review of the Waste Minimisation and Management Act (1995) scheduled to commence later this year.

A primary aim of the Inquiry Panel has been to demystify waste management issues and inform Government, business and citizens about how improved practices and technologies might contribute to sustainable waste management. The report also provides an accessible framework for considering waste management options.

The Waste Inquiry has received and considered 80 submissions during the course of the investigation. Hearings were conducted, and inspections and interviews were undertaken in various urban and regional centres of New South Wales. The Panel visited facilities in Victoria and Queensland and overseas to inspect emerging technologies and review waste management practices.

2. The Opportunity

The Waste Inquiry has been undertaken at a time when three related issues have coincided to bring waste management into special focus: favourable economic conditions are driving increased consumption and disposal; numerous pressures surround the availability of future landfill capacity; and promising new options are emerging for treatment and beneficial use of some waste resources.

This is a time of great opportunity to begin to change the paradigm of waste management in New South Wales. An abundant array of viable technologies exists to increase recycling and to gain value from various parts of the waste stream. No one technology offers a complete solution. Rather, each can form a part of an integrated management system.

Mechanical technologies and processes for recycling of plastics, glass and paper, are well developed and improving. Biological technologies are generally well proven and increasingly finding favour in European countries for production of high quality compost (and, in some cases, green energy or fuel).

The new thermal technologies are well regarded for production of green energy from specific wastes and are reaching commercial status for mixed residual waste applications. New landfill technologies accelerate waste degradation for early green energy gains and show promise in speeding waste stabilisation.

New waste management practices too are available for consideration. Integrated waste management, for instance, links markets with technologies, logistics and waste streaming to simplify the pathway from discard site to market. This philosophy is based on the idea of a systems approach in which technologies are used to serve designated purposes; to achieve market related outcomes as the servant of the management practice. A sound strategic framework can guide the choice of both practices and technologies.

3. The Approach

The foundation for the Waste Inquiry was a review of the current situation in waste management in New South Wales and the issues confronting the Government, business and citizens. This process was greatly assisted by the submissions received, hearings, informal discussions with private and public sector participants in waste management, and facility inspections.

An important further step was to examine management practices and technologies overseas and in other parts of Australia. In this way the Waste Inquiry sought answers to the fundamental questions concerning the ingredients for success in deploying waste management practices and technologies.

The bulk of the effort, however, went into identifying appropriate technology classes and types, evaluating these technologies, and determining and assessing appropriate management practices.

The Waste Inquiry has focused on municipal waste, commercial and industrial (C&I) waste and construction and demolition (C&D) waste.

4. Toward a New Way of Managing Waste

The central issue faced by the Waste Inquiry revolved around the search for a set of appropriate waste management practices and technologies to play a crucial role in securing sustainable waste management. The report contains much detail and many conclusions on issues affecting successful take-up of alternative waste management technologies and practices. A few inter-related findings however have emerged as central themes. These are discussed below, ahead of the more detailed findings and recommendations on practices and technologies.

4.1 The Triple Manifesto

The Waste Inquiry has concluded that, in waste management, choices of State or regional **technologies, practices** and **strategy** are inextricably linked. Determinations in one leg of the tripod cannot be made without impact on the other legs, and all contribute to achieving sustainable waste management.

When the three legs are in balance, as they are in Frankfurt, Portland and Salzburg, communities can best manage waste as a potential resource; not necessarily to be saved at all costs, but neither to be squandered without consideration of the economic, social and environmental merits of reprocessing.

Balance, in this case, arises when the State's strategic policy framework for waste management facilitates (and, to some extent, drives) the adoption of an array of creative waste management practices and an array of aligned technologies for treatment and disposal. It also implies that improvements in practices and technologies can influence the modification of strategy to achieve better outcomes.

The Waste Inquiry urges the Government to adopt this triple manifesto as the defining framework for waste management and Recommends that the Government move forward with its intended review of State waste management legislation and the strategic policy framework, based on moving the paradigm from waste disposal toward resource management.

4.2 The Marketplace

The second main theme concerns a much more deliberate inclusion of the marketplace for resources in the business of waste management. (See Chapters 7 and 8). The materials managed by the waste management industry (and business and citizens) can have value. But for many in the industry, the mind-set is tuned to the cost side of the business rather than the revenue side (ie, how best to efficiently manage the logistics process, in lieu of creatively building revenue by meeting market needs). This is not a balanced approach to building a viable business or industry.

The market perspective must move from its current position in the blurred background to a central focus in the business of waste management. Discovering end-market raw materials needs, and meeting those needs, ought to be the point of focus which drives adoption of innovative technologies and practices.

The Waste Inquiry Recommends that the Government lead actions to stimulate the market for recyclate:

- ***Reaffirm and drive the Government initiative for purchase of recycled materials as a matter of policy preference.***
- ***Encourage and facilitate action by waste management companies to develop raw materials end-markets by facilitating innovative commercial linkages between markets, technologies and practices; for example, by ensuring a smooth path through the various planning processes.***
- ***Ensure a consistent policy and regulatory philosophy so that material flow continuity is predictable, moderating project investment risks, and ultimately building confidence in recyclate products.***

4.3 Waste Management Technologies

The third main theme is that an ample array of technologies exists to enable management of more New South Wales waste as a potential resource. (See Chapters 5 and 6). But no one technology is suitable for all waste streams. Each class and type of technology has characteristics which make it particularly suitable for specific waste streams. The Government should guide adoption of a portfolio, that comprises all classes of technologies, on the basis of end-market demands, waste streams available and regional circumstances.

The best way for the Government to provide technology portfolio guidance is to ensure that the strategic policy framework actually enables the achievement of the Government's vision and intent. The commercial waste management sector is best positioned to own and operate technologies, and manage associated business risks.

Progressive take-up of alternative technologies is highly dependent on the comparative costs associated with traditional disposal technologies. A key cost component of course is the Section 88 disposal levy. This important economic instrument should be struck carefully to ensure that the costs and benefits of non-market externalities (particularly environmental ones) are internalised and become an explicit part of market-based waste management "gate price" decisions.

The size of the levy, and the scope to refine its application to various classes of technologies, can have a powerful influence on everyday discard or recycle choices by business and citizens through comparative cost signals. Moreover it is fundamental in shaping investment decisions by firms in the commercial waste management sector.

All stakeholders in waste management seek clarity in future policy on waste disposal taxes. Specific considerations are: the absolute amount of the levy; the technologies to which it will in future apply; and the planned rate of change of the tax. These are critical strategic waste policy issues. Striking the right tax balance is fundamental to achieving continued waste management reform. Policy continuity provides a measure of certainty on which the waste management industry can base investment decisions.

The Waste Inquiry Recommends that Government policy and management initiatives be organised to:

- ***Guide and facilitate take-up and deployment by the commercial waste management sector of a portfolio of technologies through appropriate settings in economic instruments (including the waste disposal levy), voluntary industry agreements and regulations so that each waste stream is treated to best advantage.***
- ***Provide enhanced investment and contract certainty by signalling policy intentions for the waste disposal levy in respect of amount, technology application and planned rate of change.***
- ***Provide support where appropriate in the form of low interest loans to encourage investment in, and full commercialisation of, emerging technologies.***

4.4 Integrated Waste Management Practices

The fourth theme is that no single waste management practice, treatment technology and disposal technique can handle the full array of waste sources, types and recycling possibilities. Integrated waste management is based on the idea of an overall approach coordinating logistics, waste streams, recyclables streams, treatment technologies, and markets. (See Chapter 8).

The three components of integrated waste management practice are: waste streaming, where like materials are similarly classified and collated; system integration, where responsibility for sequential activities, waste streams and geographic areas is aligned and broadened; and industry arrangements where the roles and responsibilities of the institutions and private sector corporations involved in waste management are clearly focused.

Government agencies and the private sector waste management industry are well positioned to facilitate the implementation of integrated waste management, within a Government approved strategic framework. Collaboration by Governments, business, citizens, and the waste management industry is a vital ingredient to achieving integration.

The Waste Inquiry Recommends:

- ***Inclusion of integrated waste management as part of the strategic policy framework for waste management in New South Wales so that it becomes the accepted way of organising activities.***
- ***Progressive adoption of integrated waste management practices which link each step in the supply chain and provide for a portfolio of reuse, recycling, reprocessing and disposal schemes to gain optimal value from waste as a potential resource.***
- ***Government coordination of actions to achieve integrated waste management in Municipal, C&I and C&D sectors, in collaboration with business, local government, citizens and the waste management industry. Stakeholder involvement is critical to achieving beneficial outcomes.***
- ***A short term Task Force of key Government, business and waste management industry participants, to guide planning and implementation of integrated waste management in the C&I sector. This sector has high potential for waste management and resource recovery, but waste diversion efforts to date have been limited and inconsistent.***
- ***Voluntary action, financial incentives, and ultimately regulatory action to drive capture and processing of new waste streams (identified in this report), and marketing of derived products with collaboration by business, Government, citizens and the waste management industry.***
- ***The EPA monitor implementation without delay of this program and take action to remove any roadblocks.***

4.5 Costs of Potential Improvements

The fifth main theme is that improved and integrated management practices and technologies can bring about good waste reduction outcomes at moderate cost. The report explores (Chapter 9) two scenarios for increased waste diversion over and above the carry-on-much-as-now scenario.

The Improved Scenario has an indicative system-wide cost of around 5 per cent more than now (around $29 million added to the current $571 million) but takes diversion from disposal from a current 38 per cent (municipal 25 per cent; C&I 24 per cent; and C&D 60 per cent) to 54 per cent (municipal 49 per cent; C&I 42 per cent; C&D 67 per cent).

The Aggressive Initiatives Scenario has an indicative system-wide cost of around 14 per cent more than now (around $78 million) but takes overall diversion to 69 per cent.

Achievement of such improvements is dependent on gains being made in the other themes discussed here, but would rely, as well, on a mix of policy and regulatory reforms, financial incentives and education initiatives.

The incremental costs associated with waste reduction initiatives, such as described in these scenarios , would logically be borne by State Government, Local Government, the business sector and citizens.

These indicative financial costs would be somewhat offset by reduced energy costs and indirect environmental benefits. Moreover, the analysis does not take account of the scope for efficiency improvement through integrated waste management.

The Waste Inquiry Recommends that the Government take into consideration these order of magnitude benefits and costs in framing a new waste/resource management vision.

4.6 Waste Management Strategic Policy Framework

The Waste Inquiry has not made specific recommendations on the various aspects of the strategic policy framework necessary to achieve the proposed new way of managing waste. That task is beyond the Terms of Reference of this Inquiry and will be addressed in the upcoming review of waste management legislation. But the new paradigm for waste management clearly requires some changes to the present strategic framework to enable the emerging array of practices and technologies to make their full contribution.

The foundations for such a strategy are: vision; objectives; role clarity; business and citizen involvement; funding availability, and legislation. Key ingredients are outlined below.

Vision is needed by Government and all stakeholders to complete the paradigm change to “waste as a potential resource”. The concept is now part of the waste management industry debate in New South Wales. Policy initiatives over the last five years are strengthening the resource perspective. The strategic framework for the next five years ought to entwine strategy, practices and technologies with markets for transformed materials.

Objectives are needed in order to communicate the Government’s purpose and principles in relation to waste management. Goals such as waste diversion targets should be applied to specific waste stream types.

Role clarity is critical to achieving step-changes in waste management practices and take-up of technologies. It is now opportune to consider public sector institutional structure and role options in respect of strategy, policy and management, and the role that might best be played by the commercial waste management sector. Role clarity is essential to getting the best from integrated waste management.

For example, it is the view of this Inquiry that the Government should frame the vision, strategy and policies to bring about reform; guide and facilitate sound practice and technology adoption; and allow the commercial sector to own and operate systems and manage business risks.

Business and citizen involvement in waste minimisation is crucial to achieving source separation and waste streaming, and to identifying creative opportunities for improvement. The framework particularly should consider options for engaging business to accomplish waste reduction. Industry image appears to be an important driver of waste minimisation actions.

Funding availability should encompass both private sector and public sector sources to maximise the economic efficiency of this system.

Legislation review should take into consideration the need for an integrated approach to waste management using a portfolio of financial incentives and economic instruments, voluntary planning and management agreements, education, and regulatory flow control measures.

5. Review of Current and Emerging Technologies

The Waste Inquiry assessed four separate classes, covering 14 types of waste management technologies as follows:

Mechanical Separation Technologies

- Material Sorting
- Waste Separation

Biological Technologies

- Land Application
- Open Windrow Composting
- Vermicomposting
- Enclosed Composting
- Anaerobic Digestion
- Fermentation

Thermal Technologies

- Incineration

- Pyrolysis/Gasification
- Waste Melting

Landfill Technologies

- Conventional Wet Landfill
- Conventional Dry Landfill
- Bioreactor Landfill.

These technologies are described in summary form in Box 1. The key features of each technology type are set out at Table 1. (See page 17)

Box 2 outlines preferred and suitable input waste types and the main products for each technology type.

5.1 Evaluation

The technologies were evaluated using criteria developed by the Waste Inquiry to reflect technical performance characteristics and relevant ESD issues.

The evaluation criteria used in the review cover:

Technical Issues

- Technology maturity
- Input quality flexibility
- Input quantity flexibility
- Local availability of technology and expertise

Environmental Issues

- Resource conservation
- Solid residues
- Greenhouse gas emissions
- Risk of water emissions
- Risk of air emissions

Social Issues

- Community involvement/buy-in
- Public perception
- Amenity impacts
- Employment impacts

Economic Issues

- Net costs per tonne
- Cost/scale sensitivity
- Net benefits per tonne
- Market availability for products.

The evaluation was based on the terms of reference of the Inquiry. However, there are various issues which limit comparative assessment of technologies:

- Local variations such as socio-economic factors, transportation distances for wastes and recovered resources greatly affect economic, environment and social impacts.
- Project scale greatly affects impacts, so technology scores are somewhat related to optimal project scale.
- The risks of environmental impacts to air, land, water and amenity from a facility are largely governed by the types and volumes of waste handled and the quantum of potential impacts that must be managed.
- Each generic technology has application to specific operating tasks which overlap at boundaries but differ in the main. Moreover, technologies should logically be considered in the context of their specific waste stream design application, (eg, organic waste, mixed waste, inert waste etc).

The weighting factors used in the evaluation process were determined by the Inquiry Panel Members to reflect relative importance of key issues associated with implementing the technologies at present. A variety of alternative weighting patterns was considered, and the Panel is satisfied that the one adopted best represents a balanced perspective. The results obtained were not sensitive to modest changes to the weightings applied to key criteria.

5.2 Technology Evaluation Conclusions

No single technology class can offer a complete solution by treating and processing all waste materials. Each can form part of an integrated waste management system. Moreover, technology classes and types excel in varying performance dimensions: a measure of trade-off is invariably required to balance technical, environmental, social and economic outcomes.

The choice of a portfolio of technologies should be made on the basis of regional circumstances, waste streams available and market demand for the products of reprocessing. More specifically, technology selection ought to be driven by three critical principles:

- A firm understanding that the array of technologies selected as part of an integrated system must play a pivotal role in linking markets for resources and the system of waste management practices adopted.
- Investment and operating risk can be best managed if input supply can be reasonably predicted and product demand can be reasonably judged. The most efficient allocation of these and other risks is a key factor in controlling waste management costs.
- Current and evolving circumstances provide an important context for technology choices. The complex intertwining of waste types generated, local planning, social and environment considerations, industry resource demands and geographic circumstances (along with many other issues) can provide opportunities and influence choices.

The Evaluation Results, drawn together for each technology type in Table 2, allow the following **Conclusions** to be reached:

(a) **Mechanical Technologies** perform specific purposes which essentially precede other treatment processes.

Material sorting technologies (sometimes known as MRFs) score very well due to their maturity and modest cost in sorting dry recyclables, which are then reprocessed to create new paper and packaging products or industrial materials.

Box 1 Technology Description

MECHANICAL SEPARATION TECHNOLOGIES

Material sorting

These schemes use automated and manual sorting to separate mixed recyclable materials to groups of specific materials. The outputs are suitable for reuse, recycling or reprocessing.

Waste Separation

These technologies use a variety of physical processes, such as drums and pulverisers, to separate mixed residual wastes. The aim is to recover specific waste streams for further processing or reduced volume disposal.

BIOLOGICAL TECHNOLOGIES

Land Application

These schemes involve direct injection of organic wastes to increase the availability of nutrients in farm soils. This increases soil sustainability and crop yields. Typical waste materials are sewage sludge, agriculture wastes and grease trap wastes.

Open Windrow Composting

These technologies involve decomposition of organic wastes through microbial activity under open, aerobic conditions. The compost product is stable and rich in nutrients and organic matter and is suitable as a soil conditioner.

Vermicomposting

These technologies use worms to consume organic wastes including sewage sludge, food and animal wastes. The product is high quality compost suitable for soil conditioning.

Enclosed Composting

Controlled atmosphere and moisture conditions are used in these technologies to improve the rate of organic waste decomposition (over open windrow composting) and control odours. Enclosed composting systems use drums, boxes, tunnels, silos or vessels as the core process technology. System controls provide for input of potentially odourous waste including food, sewage sludge and garden wastes, to produce good quality compost.

Anaerobic Digestion

Digestion involves controlled biological degradation of organic wastes by microbial activity in the absence of oxygen. Methane-rich gas is produced suitable as fuel for energy generation. A digestate sludge is also produced, which is suitable for enriching compost materials. Input preparation or source separation is required to ensure that waste is free of non organic contamination.

Fermentation

Fermentation technologies involve biological degradation of organic wastes to produce a chemical feedstock or liquid fuel (usually ethanol). Primary input application has been agriculture wastes, but recent developments take municipal organics including food waste and sewage sludge.

THERMAL TECHNOLOGIES

Incineration

These mature technologies recover the calorific energy contained in residual wastes. Heat and steam for electricity generation is produced through mass combustion of the input waste. The products can be used for local heating and for energy input to the grid.

Pyrolysis/Gasification

In this group of technologies, waste materials are heated in the absence of oxygen to produce a liquid fuel (pyrolysis oil) which can then be separately gasified in the presence of oxygen to produce a fuel gas (syngas). This pyrolysis oil or syngas can in turn be used to power industrial engines producing energy for input to the grid, or as a chemical feedstock.

Waste Melting

These technologies use high temperatures to oxidise or reduce waste, and melt the residual material. The output is heat and fuel gas which can be used to power industrial engines producing energy for input to the grid. A further product is recyclable metal, and inert slag remains.

LANDFILL TECHNOLOGIES

Conventional Wet Landfill

These mature technologies are used to facilitate waste decomposition in a controlled manner. As the process of biodegradation takes place methane and carbon dioxide are released and a good proportion is captured as gas suitable as fuel for electricity generation.

Conventional Dry Landfill

Dry landfills are feasible in low precipitation climates, where minimisation of infiltration inhibits the biodegradation of waste. This reduces or eliminates leachate and landfill gas formation because of the dry stable conditions.

Bioreactor Landfill

In these landfills the rate of anaerobic decomposition is accelerated by recirculation of leachate and, in some cases, addition of sewage sludge. The process aims to improve gas production and electricity generation, and reduce the time taken to achieve stabilisation.

Box 2 Suitable Input Materials and Products

Technology Class/Type	Input Waste Type(s)	Output Product(s)
Mechanical Separation Technologies		
Material Sorting	Mixed dry recyclables, including: • Paper/cardboard • Packaging plastics, paper, glass, metals.	Reprocessable materials by type.
	Industrial dry recyclables, including: • Paper/cardboard • Metals, plastics, glass • Timber, concrete, spoil	Reprocessable materials by type.
Waste Separation	Mixed residual waste.	Organic mass for biological organic processes. High calorific material (RDF) for thermal processes or reduced volume landfill Inert materials. Metals.
Biological Technologies		
Land Application	Agriculture wastes, sewage sludge, gypsum. Specific organic wastes including grease trap wastes.	Soil improvement .
Open Windrow Composting	Garden waste, sewage sludge.	Compost, soil conditioner.
Vermicomposting	Sewage sludge, food waste, garden waste.	Compost, soil conditioner.
Enclosed Composting	Mixed organic waste, including: • Food waste • Garden waste.	Compost, soil conditioner.
	Preseparated residual waste.	Compost, soil conditioner. High calorific material (RDF) for thermal processes or reduced volume landfill.
Anaerobic Digestion	Mixed organic waste, including: • Food waste • Garden waste.	Biogas fuel/green energy. Digestate material for compost.
Fermentation	Agriculture wastes: Mixed organic waste, including • Food waste • Garden waste.	Liquid fuel.
Thermal Technologies		
Incineration	Mixed residual waste. High calorific specific wastes.	Heat/steam/energy.
	Special wastes, including: • Clinical waste • Hazardous waste.	Waste destruction.
Pyrolysis/gasification	Sewage sludge, agriculture wastes. Mixed organic waste, including: • Food waste • Garden waste • Paper pulp. Preseparated residual waste.	Pyrolysis oil or Syngas/green energy.
Waste Melting	Metal wastes, hazardous waste. Mixed residual waste potential.	Syngas/green energy. Heat/energy. Metal residue.
Landfill Technologies		
Conventional Wet Landfill	Mixed residual waste.	Methane/green energy.
Conventional Dry Landfill	Mixed residual waste.	Nil.
Bioreactor Landfill	Mixed residual waste.	Methane/green energy.

Waste separation technologies score moderately for their ability to segregate mixed residual wastes so that various fractions can then be processed using specific biological or thermal technologies.

(b) The main recognised **Biological Technologies** score well on an aggregated criteria basis. The composting technologies in this group produce a moderate to high quality soil conditioner with strong market acceptance. They are mature technologies with moderate to good environmental characteristics and social impact and good economic viability.

A further biological technology, anaerobic digestion, scores slightly less on the criteria, but has energy as its main product along with organic material. Fermentation technology has not reached the same level of commercial maturity as its counterparts but can be used to produce a chemical feedstock at moderate cost. It scores moderately well on the criteria.

(c) **Thermal Technologies** are a mixed bag. Incineration, despite its maturity and input materials flexibility, scores poorly overall due to economic and social issues and low resource conservation capabilities.

The new thermal technologies, pyrolysis/gasification and waste melting technologies, are proven in specific materials applications and some pyrolysis/gasification technologies are reaching commercial status for mixed waste treatment. These technologies produce energy, at moderate cost, as their main output product.

This group of technologies scores moderately on the criteria.

(d) **Landfill Technologies** score moderately on the criteria, mainly due to their maturity (providing favourable operating performance), flexibility and low costs per tonne of input. These factors somewhat balance their poor performance in resource conservation, moderate environmental risk characteristics and low social acceptability. Bioreactor landfills and conventional wet landfills produce energy as their main product.

Each of the above technology classes should be used in a portfolio of technologies as part of an integrated waste management system that aims to maximise resource conservation at a cost acceptable to the community as a whole. Thus a technology portfolio might reasonably include a mix of:

- material sorting technologies geared to recovering high volumes of recyclable materials;
- biological and new thermal technologies (after waste separation) aimed at beneficial use of organic materials;
- landfill technologies for the inevitable remaining mixed residual waste that cannot be separated and processed at reasonable overall cost to the community.

It is not appropriate to distinguish between technology classes without reference to the waste stream to be treated. The adage: "garbage-in, garbage-out" is highly relevant. Some compost is of a quality suitable only as landfill cover, whilst some energy recovery systems are inefficient. Further, the scale of differences between the various technology types within each class is so great that it is entirely inappropriate to lump them all together, eg. thermal and biological technologies.

Moreover, care needs to be taken with the terminology "waste to energy". Technologies that create energy from waste can take several forms. Some biological technology systems produce energy as the primary product, and some thermal technology systems can produce chemical feedstock in lieu of energy. The new landfill technologies too are able to win energy from the decomposition process. It is clear that this overlapping and blurring of technologies and products will become more profound over the next five years, as suppliers seek to improve and differentiate their technologies.

The Waste Inquiry Recommends:

- ***Adoption of purpose-specific emerging technologies into waste management operations in the municipal, C&I and C&D sectors on a planned commercial basis with private sector funding, but with general facilitation as necessary by the Government through economic and regulatory instruments, financial incentives and institutional arrangements.***
- ***Project delivery and financing for technologies should be organised so that the private sector takes process, project and business risks.***

Table 2 Technology Evaluation Table

		Technical					Environmental						Social					Economic					
Evaluation Criteria		Technology Maturity	Input Quality Flexibility	Input Quantity Flexibility	Local Availability	**Subtotal**	Resource Conservation	Solid Residues	Greenhouse Gas Emissions	Risk of Water Emissions	Risk of Air Emissions	Subtotal	Community Involvement	Public Perception	Amenity Impact	Employment Impact	**Subtotal**	Net costs per tonne input	Cost/scale sensitivity	Net benefits per tonne input	Market Availability	**Subtotal**	**Total**
Evaluation Criteria Weighting (%)		8	7	6	4	**25**	6	6	5	4	4	**25**	8	8	5	4	**25**	8	7	5	5	**25**	**100**
Mechanical	Material Sorting	5	3	3	5	**19.8**	5	4	4.5	5	4	**22.5**	5	4	3	5	**21.4**	3.5	3	4	4	**17.8**	**81.5**
	Waste Separation	4.5	4	3	4	**19.6**	4	2	4	3	3	**16.0**	1	3	3	2	**11.0**	5	3	1	2	**15.2**	**61.8**
Biological	Land Application	4	1	3	4	**14.6**	4	5	4	3	4	**20.4**	1	2	4	2	**10.4**	5	3	1	3	**16.2**	**61.6**
	Open Windrow Composting	5	2	4	5	**19.6**	4	3	3	3	2	**15.4**	4	3	2	2	**14.8**	5	4	2	3	**18.6**	**68.4**
	Vermi-composting	4	2	3	5	**16.8**	4	3	4	3	3	**17.2**	4	4	3	2	**17.4**	5	3	3	3.5	**18.7**	**70.1**
	Enclosed Composting	5	2.5	3	4	**18.3**	4	3	4	5	4	**19.6**	4	4	3	3	**18.2**	4	3	2	3	**15.6**	**71.7**
	Anaerobic Digestion	5	2	3	3	**16.8**	4.5	3	4	2	3	**17.0**	3	3	3	3	**15.0**	3.5	3	2	4	**15.8**	**64.6**
	Fermentation	3.5	2	3	2	**13.6**	4	3	4	3	3	**17.2**	3	3	3	3	**15.0**	3	3	2	5	**16.0**	**61.8**
Thermal	Incineration	5	4	3	2.5	**19.2**	2	4	3	4	2	**15.0**	1	1	2	2	**6.8**	1.5	1	2	4	**9.8**	**50.8**
	Pyrolysis/ Gasification	3.5	3	3.5	3.5	**16.8**	3	4	3	3	2	**15.4**	3	3	3	3	**15.0**	3	3	2	4	**15.0**	**62.2**
	Waste Melting	2.5	5	3	3	**17.0**	3	5	3	4	2	**17.4**	2	3	3	2	**12.6**	2.5	3	2	4	**14.2**	**61.2**
Landfill	Conventional Wet Landfill	5	4	5	5	**23.6**	1	1	2	2	3	**8.4**	2	2	1	2	**9.0**	5	5	1	4	**20.0**	**61.0**
	Conventional Dry Landfill	5	4	5	5	**23.6**	1	1	3	3	5	**11.8**	2	2	1	2	**9.0**	5	5	1	1	**17.0**	**61.4**
	Bioreactor Landfill	4	4	5	4	**21.2**	1	1	2	3	3	**9.2**	2	2	2	2	**10.0**	5	5	1	4	**20.0**	**60.4**

Note: Indicative assessment based on broad technology classes and types, not brands.

6. Review of Current and Emerging Waste Management Practices

The practices adopted in managing discarded materials are fundamental to both protecting the environment, and using waste as a resource. The Waste Inquiry has found that sustainable waste management should be guided by a clear strategy which employs simple but sound practices. These practices must be in touch with the community psyche, market-based where possible, and underpinned by a robust strategic policy framework.

The waste management practices adopted should **lead** selection of the array of technologies employed in the solution, rather than the reverse.

The Waste Inquiry assessed three separate classes, covering nine types of waste management practices as follows:

Waste Minimisation Practices

- Material recycling
- Product reuse
- Waste avoidance

Integrated Waste Management Practices

- Waste streaming
- System integration
- Industry arrangements

Market Development Practices

- Alternative recyclate uses
- Quality standards
- Market intervention.

The main features of each practice type are set out at Table 3. Box 3 presents a description of the focus and drivers of the various practices. (See page 18)

The management practices were broadly assessed against operational, environmental, social and economic criteria, similar to the ones used in reviewing the technologies.

6.1 Management Practices Assessment Conclusions

The Waste Inquiry has found that effective management practices are driven by three major principles:

- Minimising the amount of waste inappropriately disposed of by "enabling" the practices described in the waste hierarchy, with priority accorded to waste avoidance.
- Viable end-markets for discarded resources. They need to be founded on economic good sense as well as resource conservation goals.
- Integrated waste management aimed at efficiently supplying consistent quality resources to the highest value end-markets.

6.1.1. Waste Minimisation Practices

(a) Achieving More Recycling and Reprocessing

There is strong community support for recycling, and it is based on a well developed sense that the practice is both good for the environment and is an accessible way of making a personal contribution. Ample capacity and goodwill exists for an increased contribution by business and citizens to the general recycling effort. Creative management practices can be deployed to encourage and facilitate easier recycling.

It is technically feasible to recover and recycle most discarded materials. Technical system barriers to significantly increased recycling relate to the cost of recovering, sorting and reprocessing of recyclate. Entrepreneurial action and technology innovations are leading to cost savings in each of these activities.

The market issues concern recyclate product consistency and market price stability. Both are tackled in Europe and North America by specification of various graded quality standards and development of local and international recyclate markets.

The C&I sector in particular warrants special attention. Although significant volumes of glass and paper are already captured, more is readily available and other materials could be recycled in greater volume.

Many small/medium enterprises (SMEs) have a waste stream that is up to 95 per cent commercial/ industrial recyclables and only 5 per cent food or other contaminants. A smart system would make it easy to keep the real waste out of the mixed recyclable stream by providing collection technology geared to intercepting and capturing waste before it becomes mixed and uneconomic to recover. One way forward is to bring about collaborative recycling for industrial estates, shopping centre tenants and other business clusters.

Changing the price structure for C&I waste management to provide financial incentives to reduce residual waste capacity and use recycling bins is an important tactic to bring about increased recycling in the C&I sector. This is done overseas by relating charges more to weight or volume, and less to a "per lift" basis.

The current technology and pricing arrangements result in high costs for many SMEs that seek to participate in recycling.

Social and community barriers to greatly increased recycling relate to convenience and message reinforcement. The opportunities for public place recycling in New South Wales are minimal and therefore non-reinforcing: public place streaming technology is limited and colour coding is inconsistent.

Financial incentives too can make a contribution to greater municipal recycling when used in combination with strong communication of the benefits of recycling. European and North American cities have successfully differentiated pricing for recyclables from mixed residual waste, and provide distinguishable incentives for reduced volumes of residual wastes.

Table 3 Key Features of Waste Management Practices

Technology Class/Type	Key Features
Waste Minimisation Practices	
Material Recycling	• Good resource conservation (virgin material avoidance, energy savings). • Emissions reduction. • Net benefit on sustainability benefit/cost analysis. • Strong community support and goodwill.
Product Reuse	• Excellent resource conservation and economic benefits. • Community involvement with minimal awareness of benefits. • Traditional concept, partly supplanted by lightweight packaging and recycling.
Waste Avoidance	• Clean production. • Sustainable consumption.
Integrated Waste Management Practices	
Waste Streaming	• Source separation of wastes to various nominated organic, municipal recyclable, industrial recyclable and hazardous waste steams. • Enables material recovery and reduces need for (later) waste separation. • Facilitates integrated waste management by reducing the mixed residual waste stream.
System Integration	• Links markets, technologies, logistics, waste streams and geographic areas. • Facilitates discovery and exploiting of opportunities for recycling and reprocessing.
Industry Arrangements	• Organisation of waste management geared to innovation in technology and management practices. • Public sector and private sector waste management industry are well resourced and skilled.
Market Development Practices	
Alternative Recyclate Uses	• Diversification of end use applications can strengthen and stabilise demand. • Specifications and regulations need to be geared to accommodate recycled alternative materials.
Standards	• An appropriate array of standards can act to improve recycled product marketability. • Confidence and trust can be enhanced through adherence to established quality standards.
Market Intervention	• Intervention through economic instruments, subsidies and grants, and risk sharing can be crucial in developing markets for recycled materials. • Product/market development through business and Government commitment to purchase recycled materials and products.

The Waste Inquiry Recommends that the following reforms should be adopted by Government and the waste management industry:

- ***Organise on-site recycling and collection systems, and pricing for the C&I sector to match the physical circumstances and discard streams of each business and its cluster setting. The C&I sector can be tackled successfully by a Task Force comprising Government, waste management industry, and business sector representatives.***

  The Government could contribute to this process by establishing appropriate targets for business waste reduction for C&I sub sectors, and working with business leaders from each sub sector to develop sub sector "business waste reduction plans" eg. food supermarkets, retail shopping centres etc. The Task Force referred to in Section 4 (d) above and could be used to establish the collaborative process.
- ***Provide a universal colour coding system to encourage and reinforce recycling. The coding system ought to feature a standard colour depicting each recyclable material, predictable (if not standard) bin shapes in public places (including footpaths and train stations), and a standard cluster of material discard opportunities at each public location (eg, plastic, glass, metal, paper – food might be a later addition).***
- ***Introduce a "Waste-Not" DCP requirement in relation to all Local Government approvals.***
- ***Progressively change waste management pricing arrangements for the municipal sector: to provide real financial incentive for smaller residual bin size (or, ultimately, less frequent collection); and to shift ratepayer charges more to residual waste and less to recyclables collection.***

(b) Achieving More Product Reuse

Product reuse accrues powerful environmental benefits, but more could be done to encourage the practice given its elevated position in the waste hierarchy. A key issue is how best to unite buyers and sellers when the value of the reusable products is low. Europe and the United States have successfully established "drop-off" centres to capture end-of-first-life bulky household and commercial products and promote extended producer responsibility/product stewardship. These highly successful centres are conveniently located and attractive to visit.

A pilot drop-off centre is currently proposed by Western Sydney Waste Board as a full-scale trial to prove the viability of the concept. It appears to be viable on commercial and economic grounds.

The Waste Inquiry Recommends support for the proposed drop-off centre pilot trial through Government and (if possible) business funding, and, if successful, private sector participation in future drop-off centres.

(c) Commitment to Recycling

Most communities don't count the benefits of waste minimisation, and particularly recycling, in narrow economic terms. However, the existence of strong private sector participants in the market does indicate that recycling can be profitable in the right circumstances. This Report demonstrates that the economic and environmental benefits of recycling go close to covering direct and indirect costs. Logistics efficiencies, improved technologies and developed markets can consolidate economic, environmental and social sustainability. Moreover the marginal cost of increased recycling is considerably less than the marginal benefits given the infrastructure in place.

The Waste Inquiry Recommends that the Government reassert its commitment to material recycling in the strongest terms, to provide community confidence and encourage increased participation by business and citizens.

6.1.2. Integrated Waste Management Practices

(a) System Integration

Waste management activities in New South Wales are organised as sequential steps in which management and materials ownership shifts from one participant to the next. For the municipal streams, four and sometimes five specialist organisations play a part in the journey from discarding to disposal or reprocessing organisations. Adding the C&I and C&D discard streams brings further participants into the business of managing waste. At present each participant in the management process logically seeks to optimise their own position, which works against the interests of overall system optimisation. This way of managing is inefficient and limits potential for discovering and exploiting new opportunities for recycling and reprocessing materials.

Waste management and recycling practice could be greatly improved by adoption of a more integrated approach which strengthens the links between steps in the supply chain, various waste streams, processing technologies, and geographic areas.

Integrated waste management practice, widely adopted overseas, is based on the idea of an overall approach. It is a central plank of the recently developed waste management strategy for England and Wales, and is routine practice in many other parts of Europe and the USA. It involves moving beyond the current fragmented but evolving approach, to synergistically link and combine sequential activities, and various types of waste streams, and wider geographic areas, together with appropriate processing technologies. This practice can not only increase the scale and efficiency of operations, but can also provide rewards for action to support diversion of resources from disposal to reuse, recycling and reprocessing.

System integration implies an approach that incorporates in single contracts and/or agreements:

- increased value chain activities, including collection, transfer, transport, MRF sorting, treatment, selling, and/or disposal;

- geographic areas larger than a single local council collection zone – possibly two or three per Waste Board region;
- inclusion of recyclables, special collections, such as garden waste collection, and residual waste;
- scope for capture by the contractor of C&I and C&D waste and recyclables from these streams within the relevant geographic area.

The Waste Inquiry Recommends that the Government initiate a detailed examination of how best to bring about the structural reforms needed to bring about the structural reforms needed to implement the practice of integrated waste management. Achievement of effective integration will require collaboration between the private sector waste management industry, Government, Local Government and public sector interests.

(b) Waste Streaming at Source

The complexity and cost of recycling and reprocessing discarded materials is strongly related to the extent to which they become mixed with incompatible materials. Greatly increased recovery of materials can be accomplished by selective and increased streaming at source. Prime candidates are:

- Municipal Sector: garden waste, household bulky waste, dry recyclables, household hazardous waste, and (in appropriate circumstances) food waste.
- C&I Sector: food waste, office paper, dry recyclable materials, and industrial materials (plastics, glass, metals, timber).
- C&D Sector: soil/rubble, metals, timber and concrete.

Effective streaming requires standardised technologies, coded to specific waste streams in all business locations and all public places. The existence of an array of discard options confronts the disposer with a choice between waste and beneficial use. The more universal this choice in the daily routines of individuals, in home, work and leisure activities, the more the message of resource recovery is reinforced.

Care is needed however to ensure that expansion of supply matches the potential to increase market demand. A blanket move to immediately collect all garden waste for instance could result in a damaging oversupply situation. A more appropriate strategy is a staged increase in supply, together with action to stimulate demand.

Business waste streaming and recycling opportunities are sporadic and depend on the environmental commitment of business leaders, and the responsiveness of waste management companies. Technical system barriers are associated with contract arrangements, source separation technology, work space layout and employee education. These barriers can be addressed in large measure by seeking manageable commitments from business; for example, facilitating source separation of only the single dominant waste material at a specific business location, rather than pushing ineffectively for three or four materials streams.

This scheme will require leadership and coordination, deployment of appropriate collection technologies together with education, financial incentives and increased business responsibility for contributing to resource recovery.

The Waste Inquiry Recommends Government/waste management industry collaboration to drive adoption of principles and measures which lead to waste streaming at the point of discard. These include:

- ***Contract arrangements that enable business clusters to pool waste management arrangements to maximise streaming.***
- ***Provision of services and facilities to capture separately the main municipal discard streams in a controlled expansion of supply to match increasing market demand.***
- ***Government leadership in changing the business waste management paradigm from waste collection/disposal to resource management: total waste management rather than fragmented transport services. This will require coordination, education, economic instruments and appropriate regulatory action.***

(c) Industry Arrangements

New South Wales is well positioned to achieve further waste management reform through its public sector waste policy and management agencies and private sector waste management and recycling industry. The resources and skills available to the community, operating in a competitive framework, provide a favourable basis for the development of greatly improved management practices and the uptake of innovative technologies to efficiently transform wastes to resources.

The Waste Inquiry believes that innovation in waste management practice and technology development is best served by the existence of a competitive market framework in the waste and recycling sector. An adequately resourced and skilled commercial waste management industry exists in New South Wales. This sector should take responsibility for the commercial risks associated with the delivery, ownership and management of new technologies and practices.

Regional waste planning and management has been considerably strengthened by the creation of the Waste Boards, but greater coordination is necessary (particularly across the Sydney Metropolitan Area). Further, the role of the Boards should be clarified and defined in terms of regional outcomes to be achieved.

A properly independent advisory body with expertise in waste strategy, management and operations is needed to provide the Government with strategic advice on significant waste management issues.

The Waste Inquiry Recommends that the Government:

- ***Adopt the proposed institutional reforms to improve Waste Board performance.***
- ***Establish a body of waste management stakeholders to provide an alternative source of waste management policy and strategic advice to Government.***
- ***Engage the commercial waste management industry to manage investment and operating risks associated with adoption of innovative practices.***

(d) Research and Development

Research and Development is poorly funded throughout Australia in relation to the scale of the opportunity available for innovative technologies and practices. There is a clear need for increased research to:

- assist in developing and commercialising Australian technologies, and demonstrating these to global markets;
- further develop and apply Life Cycle Analysis to inform policy and operating decisions;
- trial and demonstrate the viability of alternative waste management practices.

The Waste Inquiry Recommends development and funding of a broad-based five year R & D program, with priorities established by the Task Force referred to at Section 4 (d) above.

6.1.3. Market Development Practices

Market barriers to greatly increased recycling are associated with demand; key factors are resistance to using recyclate in new products, price fluctuations and quality consistency. The German response to these issues involves legislative recyclate content specification; the UK and North America have opted for promotion and persuasion. Many see global markets as a key to increased demand. Development of new, high value uses for recyclate, beyond traditional sectors, is now seen as critical for market stability.

Overseas experience has shown that a substantial coalition of effort by Government, business and citizens is essential to creating viable stable markets for recycled materials. A package of market stimulation measures and quality standards remains an imperative to building sustainable markets.

Five issues are important in market development:

- use of economic instruments based on the financial incentive principles employed in the Government's successful Load Based Licensing program.
- review of the size and application of the Section 88 waste levy;
- action to stimulate alternative uses of recyclate in order to diversify end-market applications;
- development of an array of appropriate quality standards for each recyclate type, so that broader market choice opportunities are created;
- direct intervention by Government (such as extending the policy preference for recycled products) in order to strengthen market demand.

The Waste Inquiry Recommends a specific review by Government of market development initiatives for recycled materials.

7. Scenario Development

Illustrative scenarios were developed to demonstrate what might be achievable by integrating improved management practices and compatible technologies. These cover each waste generating sector: municipal, commercial and industrial and construction and demolition. The three scenarios compared encompass plausible and reasonably efficient options to gain progressively more value from waste.

Scenario 1.

Carry on much as now.

- based on current systems of waste minimisation and management.

Scenario 2

Improve current initiatives

- based on increased recycling and streaming of various wastes.

Scenario 3

Aggressive initiatives

- incorporating a variety of initiatives to capture and beneficially use waste streams.

The illustrative outcomes, taking account of indicative financial costs and revenues are set out at Table 4. The main conclusions from this scenario analysis are:

- Significant further gains can be made in waste minimisation at modest cost. Based on the waste flow plans associated with each scenario (See Box 4), the following indicative total cost estimates can be derived:

Scenario 1	$571 million
Scenario 2	$600 million
Scenario 3	$649 million.

- The net incremental cost increases between scenarios arise from specific waste diversion initiatives covering each waste sector.
- The incremental cost of moving from Scenario 1 to Scenario 2 is thus an indicative $29 million, distributed as follows:

Municipal sector:	$13 million
C&I sector:	$9 million
C&D sector:	$7 million.

- The incremental cost of moving from Scenario 1 to Scenario 3 is an indicative $78 million, made up as follows:

Municipal sector:	$31 million
C&I sector:	$31 million
C&D sector:	$16 million.

- The C&D sector offers good scope for further recycling without major overall cost impost, though already some 60 per cent of this waste is recycled or reused (a proportion of it as landfill cover).
- There are immediate opportunities for further waste minimisation in the C&I sector to Scenario 2 level without major overall financial cost impost.

Table 4 Scenerio indicative financial outcomes

	MUNICIPAL	C&I	C&D
Scenario 1 (Current)			
Per cent Diverted	25	24	60
Cost per tonne	$139.23	$81.43	$59.95
Scenario 2 (Improved)			
Per cent Diverted	49	42	67
Cost per tonne	$146.33	$85.63	$62.72
Scenario 3 (Aggressive)			
Per cent Diverted	66	63	76
Cost per tonne	$156.40	$95.97	$66.35

- Additional moderate financial costs are likely to result from the improved and aggressive initiative scenarios in the municipal sector.

Numerous caveats in relation to this modelling are described in the report. One is important to note here. Technology **types** are deliberately left unidentified in the scenario modelling. Moreover, other technology **classes** could be substituted for the ones nominated. For example:

- A variety of technologies could be used effectively in lieu of composting technologies to process garden waste and organic waste and produce beneficial products (eg, anaerobic digestion, pyrolysis/gasification and fermentation).
- A variety of treatment technologies suitable for residual waste processing could be used to divert, treat and recover a measure of residual waste modelled to landfill (eg, biological technologies and thermal technologies, in association with varying levels of waste separation).

Box 4 Scenerio Resource Flows

SCENARIO 1 FLOW PLAN

Sector	Streamed, Recycled (% Of total)	Streamed, Recycled (mtpa)	Residual (mtpa)	Total (mtpa)
Municipal	25	0.450	1.350	1.800
C&I	24	0.500	1.600	2.100
C&D	60	1.500	1.000	2.500
Total	**38**	**2.450**	**3.950**	**6.400**

SCENARIO 2 FLOW PLAN

Sector	Streamed, Recycled (% Of total)	Streamed, Recycled (mtpa)	Residual (mtpa)	Total (mtpa)
Municipal	49	0.886	0.914	1.800
C&I	42	0.888	1.212	2.100
C&D	67	1.682	0.818	2.500
Total	**54**	**3.456**	**2.994**	**6.400**

SCENARIO 3 FLOW PLAN

Sector	Streamed, Recycled (% Of total)	Streamed, Recycled (mtpa)	Residual (mtpa)	Total (mtpa)
Municipal	66	1.188	0.612	1.800
C&I	63	1.319	0.781	2.100
C&D	76	1.900	0.600	2.500
Total	**69**	**4.407**	**1.993**	**6.400**

Table 1 Main Features of Technologies

Technology Class/Type	Main Features
Mechanical Separation Technologies	
Material Sorting	• Mature technologies. • Accept moderate variety of municipal and commercial dry recyclable materials. • Good resource conservation. • Main product is recyclate for further reprocessing. • Good benefit/cost position.
Waste Separation	• Mature, robust technologies. • Accept mixed residual waste as input. • Main products are specific separated resource streams for further processing. • Good benefit/cost position.
Biological Technologies	
Land Application	• Simple technologies. • Accept limited input waste types. • Controls needed to avoid nutrient runoff. • Good soil improvement. • Moderate/good benefit/cost position.
Open Windrow Composting	• Simple, mature technologies. • Accept limited input waste types. • Best performed at commercial scale. • Compost quality related to input contamination. • Good benefit/cost position.
Vermicomposting	• Simple technologies, at commercial operating status. • Accept limited input waste types. • Compost quality related to input material. • Good benefit/cost position.
Enclosed Composting	• Mature, robust technologies. • Accept moderate variety of input waste types. • Good environmental features. • Compost quality related to input contamination. • Good benefit/cost position.
Anaerobic Digestion	• Mature, robust technologies. • Accept limited input waste types. • Products are both energy and compost input. • Moderate/good benefit/cost position.
Fermentation	• Reaching commercial status for mixed organic wastes. • Accept moderate variety of input waste types. • Main product is ethanol for energy production. • Moderate benefit/cost position.

continued

Table 1 Main Features of Technologies (continued)

Technology Class/Type	Main Features
Thermal Technologies	
Incineration	• Mature, robust technologies. • Accept wide variety of input waste types. • Poor/moderate resource conservation. • Require considerable air emission control equipment. • Products are both energy and heat. • Poor benefit/cost position.
Pyrolysis/Gasification	• At commercial operating status for specific wastes, reaching commercial status for preprocessed residual waste. • Accept moderate variety of input waste types. • Main product is syngas or oil used for energy production. • Moderate benefit/cost position.
Waste Melting	• Commercial operating status for metal wastes, not yet commercial status for mixed residual waste. • Accept limited (but possibly expanding) variety of wastes. • Main products are heat and syngas used for energy production. • Poor to moderate benefit/cost position.
Landfill Technologies	
Conventional Wet Landfill	• Mature, robust technologies. • Accept wide variety of waste types. • Poor resource conservation. • Main product is methane, used for energy production. • Moderate benefit/cost position.
Conventional Dry Landfill	• Mature, robust technologies • Accept wide variety of wastes. • Poor resource conservation. • Moderate benefit/cost position.
Bioreactor Landfill	• Robust technologies, at commercial status. • Accept wide variety of wastes. • Poor resource conservation. • Main product is methane, used for energy production. • Moderate benefit/cost position.

Box 3 Focus & Drivers of Waste Management Practices

Practice System	Product/Market Focus	Facilitators	Key Drivers	Requirements
Waste Minimisation				
Waste Avoidance	Direct reduction of virgin material usage.	Business Households.	Business innovation.	Industry responsibility, community concern.
Product Reuse support.	Product life extension for design purpose and new uses.	Business Households.	Business and citizen commitment.	User innovation, community
Material Recycling	Reprocessing of mainly paper/board, packaging, organics, metals, building	Business Households.	Business and citizen commitment	Participation and support, based on suitable quality standards and clarity of materials.requirements.
Integrated Waste Management				
Waste Streaming	Resource market focus with planned streaming.	Waste Boards.	Waste management practice leadership	Commercial returns, suitable collection and treatment technologies.
System Integration	System synergy by linking markets, process steps, waste streams and geographic areas.	Waste Boards	Waste management practice leadership.	Management improvement, cost reduction.
Industry Arrangements	Sustainable management of discarded resources.	Waste mgt industry. Government.	Waste management practice leadership	Clarity of objectives, roles and authority. .
Market Development				
Alternative Recyclate Uses	New, diverse uses beyond . original purpose	Waste mgt industry. Waste Boards.	Market diversity.	Business innovation.
Quality Standards	Array of specifications providing user choice	EPA.	Market perspective.	Linkage between market needs and resource availability.
Market Intervention	Economic instruments, content requirements,incentives and partnerships.	Government.	Enabling policy.	Reasonable market certainty.

RECOMMENDATIONS: **A New Way of Managing Waste**

A consolidated list of all Recommendations is set out below.

The Triple Manifesto

Recommendation 1

The Waste Inquiry urges the Government to adopt this triple manifesto as the defining framework for waste management and Recommends that the Government move forward with its intended review of State waste management legislation and the strategic policy framework, based on moving the paradigm away from waste disposal toward resource management.

The Marketplace

Recommendation 2

The Waste Inquiry Recommends that the Government lead actions to stimulate the market for recyclate:

2.1 Reaffirm and drive the Government initiative for purchase of recycled materials as a matter of policy preference.

2.2 Encourage and facilitate action by waste management companies to develop raw materials end-markets by facilitating innovative commercial linkages between markets, technologies and practices;. for example, by ensuring a smooth path through the various planning processes.

2.3 Ensure a consistent policy and regulatory philosophy so that material flow continuity is predictable, moderating project investment risks, and ultimately building confidence in recyclate products.

Waste Management Technologies

Recommendation 3

The Waste Inquiry Recommends that Government policy and management initiatives be organised to:

3.1 Guide and facilitate take-up and deployment by the commercial waste management sector of a portfolio of technologies through appropriate settings in economic instruments (including the waste disposal levy), voluntary industry agreements and regulations so that each waste stream is treated to best advantage.

3.2 Provide enhanced investment and contract certainty by signalling policy intentions for the waste disposal levy in respect of amount, technology application and planned rate of change.

3.3 Provide support where appropriate in the form of low interest loans to encourage investment in, and full commercialisation of, emerging technologies.

Integrated Waste Management Practices

Recommendation 4

The Waste Inquiry Recommends:

4.1 Inclusion of integrated waste management as part of the strategic policy framework for waste management in New South Wales so that it becomes the accepted way of organising activities.

4.2 Progressive adoption of integrated waste management practices which link each step in the supply chain and provide for a portfolio of reuse, recycling, reprocessing and disposal schemes to gain optimal value from waste as a potential resource.

4.3 Government coordination of actions to achieve integrated waste management in Municipal, C&I and C&D sectors, in collaboration with business, local government, citizens and the waste management industry. Stakeholder involvement is critical to achieving beneficial outcomes.

4.4 A short term Task Force of key Government, business and waste management industry participants, to guide planning and implementation of integrated waste management in the C&I sector. This sector has high potential for waste management and resource recovery, but waste diversion efforts to date have been limited and inconsistent.

4.5 Voluntary action, financial incentives, and ultimately regulatory action to drive capture and processing of new waste streams (identified in this report), and marketing of derived products with collaboration by business, Government, citizens and the waste management industry.

4.6 The EPA monitor implementation without delay of this program and take action to remove any roadblocks.

Costs of Potential Improvements

Recommendation 5

The Waste Inquiry Recommends that the Government take into consideration these order of magnitude benefits and costs in framing a new waste/resource management vision.

Current and Emerging Technologies

Recommendation 6

The Waste Inquiry Recommends:

6.1 Adoption of purpose-specific emerging technologies into waste management operations in the municipal, C&I and C&D sectors on a planned commercial basis with private sector funding, but with general facilitation as necessary by the Government through economic and regulatory instruments, financial incentives, and institutional arrangements.

6.2 Project delivery and financing for technologies should be organised so that the private sector takes process, project and business risks.

Waste Management Practices

Achieving More Recycling and Reprocessing

Recommendation 7

The Waste Inquiry Recommends that the following reforms should be adopted by Government and the waste management industry:

7.1 Organise on-site recycling systems and pricing for the C&I sector to match the pyhsical circumstances and discard of each business and its cluster setting. The C&I sector can be tackled successfully by a Task Force comprising Government, waste management industry, and business sector representatives.

The Government could contibute to this process by establishing appropriate targets for business waste reduction for C&I sub sectors, and working with business leaders from each sub sector to develop sub sector "business waste reduction plans". eg, food supermarkets, retail shopping centres etc. The Task Force referred to in Section 4 (d) above and could be used to establish the collaborative process.

7.2 Provide a universal colour coding system to encourage and reinforce recycling. The coding system ought to feature a standard colour depicting each recyclable material, predictable (if not standard) bin shapes in public places (including footpaths and train stations), and a standard cluster of material discard opportunities at each public location (eg, plastic, glass, metal, paper – food might be a later addition).

7.3 Introduce a "Waste-Not" DCP requirement in relation to all Local Government approvals.

7.4 Progressively change waste management pricing arrangements for the municipal sector: to provide real financial incentive for smaller residual bin size (or, ultimately, less frequent collection); and to shift ratepayer charges more to residual waste and less to recyclables collection.

Waste Management Practices Achieving More Product Reuse

Recommendation 8

The Waste Inquiry Recommends support for the proposed drop-off centre pilot trial through Government and (if possible) business funding, and, if successful, private sector participation in future drop-off centres.

Waste Management Practices Commitment to Recycling

Recommendation 9

The Waste Inquiry Recommends that the Government reassert its commitment to material recycling in the strongest terms, to provide community confidence and encourage increased participation by business and citizens.

Waste Management Practices System Integration

Recommendation 10

The Waste Inquiry Recommends that the Government initiate a detailed examination of how best to bring about the structural reforms needed to implement the practice of integrated waste management. Achievement of effective integration will require collaboration between private sector waste management industry, Government, local government, and public sector interests.

Waste Management Practices
Waste Streaming at Source

Recommendation 11

The Waste Inquiry Recommends Government/waste management industry collaboration to drive adoption of principles and measures which lead to waste streaming at the point of discard. These include:

11.1 Contract arrangements that enable business clusters to pool waste management arrangements to maximise streaming.

11.2 Provision of services and facilities to capture separately the main municipal discard streams in a controlled expansion of supply to match increasing market demand.

11.3 Government leadership in changing the business waste management paradigm from waste collection/disposal to resource management: total waste management rather than fragmented transport services. This will require coordination, education, economic instruments and appropriate regulatory action.

Waste Management Practices Industry Arrangements

Recommendation 12

The Waste Inquiry Recommends that the Government:

12.1 Adopt the proposed institutional reforms to improve Waste Board performance.

12.2 Establish a body of waste management stakeholders to provide an alternative source of waste management policy and strategy advice to Government.

12.3 Engage the commercial waste management industry to manage investment and operating risks associated with adoption of innovative practices.

Waste Management Practices Research and Development

Recommendation 13

The Waste Inquiry Recommends development and funding of a broad-based five year R & D program, with priorities established by the Task Force referred to at Section 4.4 above.

Waste Management Practices Market Development

Recommendation 14

The Waste Inquiry Recommends a specific review by Government of market development initiatives for recycled materials.