WRIGHT CORPORATE STRATEGY PTY

Focused Innovation

ACT NO WASTE STRATEGY & TARGETS

REVIEW & ASSESSMENT OF OPTIONS

Report to ACT NOWASTE

July 2008

ACT NO WASTE STRATEGY & TARGETS

REVIEW & ASSESSMENT OF OPTIONS

REVISED FINAL REPORT

Prepared for

ACT NOWaste

Prepared by

Wright Corporate Strategy
July 2008

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Revision History

REVISION	DATE	DETAILS
Draft 1	Aug 07	Review & Assessment of Options released to ACT NOWaste for review and comment
Draft 2	Nov 07	Scope varied and draft report re-issued to ACT NOWaste for review and comment
Draft 3	Feb 08	Scope varied and draft report re-issued to ACT NOWaste for review and comment
Draft 4	Apr 08	Revised draft re-issued to ACT NOWaste for review and comment
Draft 4	Jun 08	Scope varied and economic assessment included re-issued to ACT NOWaste for review and comment
Final	Jul 08	Final report released to ACT NOWaste

Executive Summary and Recommendations

Key Findings

This study of the ACT No Waste Strategy and Targets was initiated following a Government Review, which found that:

"the goals set out in the No Waste by 2010 strategy developed by the former Government are not achievable within current budget allocations. The Government recognises the achievements of the ACT community and remains committed to reducing landfill waste, but will review targets to an affordable and achievable level."

In respect of the findings of that review, this study has:

- ✓ established that the significant progress over the past twelve years in reducing the amount of waste disposed to landfill is in danger of regressing, if the signs emerging in the last 18 months continue;
- ✓ tested the individual initiatives embodied in the ACT No Waste Strategy and Targets and finds them to be realistic and achievable within the constraints of the materials that appear to be contained within the waste streams;
- ✓ identified that the present recurrent budget of ACT NOWaste is not adequate to maintain on-going waste management and resource recovery activities, even in the event that no further initiatives to improve resource recovery are implemented.

The most significant findings that have emerged through the investigations and analysis undertaken as part of this study are:

- *the good progress to date in reducing waste to landfill is being eroded and landfill disposal is on the increase;*
- *annual growth, demands annual increments in operating budgets, and future requirements for landfill capacity demands additional budgetary allocations of capital – on this basis, the waste budget cannot be held at the current level;*
- *further progress in resource recovery is supported by economic assessment, but landfill gate fee revenues skew financial assessment against efforts to minimise landfilling of waste;*
- *"No Waste by 2010" needs to be replaced by a more contemporary strategy and associated policy that does not rely on mixed waste processing as the underpinning technology to deliver the objectives.*

Going backwards or just standing still is not consistent with the Government's efforts towards creating a sustainable city.

These findings are explained below.

In respect of the ACT No Waste Strategy and Targets delivering on reducing waste, the study has found that:

- during the last ten years the amount of waste generated in the ACT increased at an average annual rate of around 6.8% – outstripping both the population growth rate and the growth in Gross State Product;
- the ACT No Waste Strategy has resulted in unprecedented improvement in resource recovery – from just 22% of waste generated in 1993/94 to 74% recovery of waste generated in 2006/07, amounting to 566,000 tonnes of total resource recovery in 2006/07;
- the 12-year history of year-on-year improvements in the amount of resource recovery ended in 2006/07 when a decrease in resource recovery was recorded;
- the high early gains in reducing disposal has continued through to 2005/06 when the trend was halted with an increase in waste disposal; and indications from 2007/08 are that this increase in disposal is continuing.

The relentless pressures from steady population growth, increasing prosperity and increasing rates of waste generation, clearly signal that further slipping can be expected if efforts are not continued to increase participation in resource recovery and waste avoidance by the ACT residential and business sectors.

In respect of containing the ACT NOWaste budget within the existing recurrent budget, the study has identified that:

- faced with growing total quantities of wastes to be managed, it is an unacceptable expectation that the ACT Government can consider reducing, or even containing at current levels, the recurrent budget;
- the budget allocation will need to be increased simply to maintain existing services, otherwise existing services will need to be cut; as a minimum, there will be growth in the recurrent budget as a result of –
  - growth in waste generation,
  - growth in the population being serviced, and
  - escalation in contract costs for the delivery of contracted services;
- the budget data reviewed has considerably under-forecast the demand for forward capital expenditure in waste management; this is particularly the case in relation to the demand for creating new landfill cells, closing old cells and the long-term maintenance of closed cells.

With annual increases in operating costs and significant capital demands for landfill cell management in the near future, the recurrent budget for ACT NOWaste will need to increase appreciably.

In respect of economic and financial considerations, the study has identified that:

- significant employment benefits are created through increasing resource recovery compared with an economy that relies heavily on landfill disposal;
- intergenerational benefits will accrue through eliminating unnecessary disposal of resources to landfill, and a commensurate reduction in demand for replacement resources today;
- as efforts at resource recovery are intensified, the environmental impacts from less waste being landfilled are reduced;
- from a community perspective, less waste being landfilled leads to improvements in economic benefit;
- landfill gate fees in the ACT have been escalated to the full triple bottom line recovery level as a key tool in securing behaviour change and to drive the community away from dependence on land-based disposal of wastes;
- if behaviours do not change and dependence on land-based disposal continues, landfill revenues become over inflated well beyond the financial cost recovery point;
- from a Government perspective, as efforts at resource recovery are intensified, the reduced revenues from less waste being landfilled leads to a net increase in financial cost.

Further efforts at resource recovery are supported by economic analysis, job creation opportunities and intergenerational benefits; however revenues received by the Government from high landfill gate fees present land-based disposal as more financially attractive.

In respect of the feasibility of the initiatives included in the No Waste Strategy and Targets, the study has identified that:

- the materials targeted for recovery in the initiatives appear to be present in the respective waste streams in sufficient quantity to indicate that the targets are realistic and achievable;
- technologies for source separation of wastes and waste stream processing are currently available and sufficiently demonstrated to achieve the objects sought from the initiatives, without high levels of risk or cost exposure to the ACT community;

- source separation of the putrescible (wet) fraction from both domestic and commercial waste streams, affords clear opportunity for low-cost resource recovery from the remaining dry (putrescible-free) stream;
- the promise of mixed waste processing technologies delivering a total alternative solution to landfill disposal has not been achieved, and remains doubtful in the Australian regulatory and environmental context for the foreseeable future.

Progress in further resource recovery is feasible, practicable and economically justifiable, using current and immediate near-term waste management technologies and practice. However, *No Waste by 2010,* based introduction of mixed waste processing technology, is no longer contemporary and work is now needed on a new waste management and minimisation strategy that is based on new policy options and contemporary technology options that emerge from this review.

Financial and Economic Modelling

The primary analysis for this study has been to look at the ramifications of the ACT No Waste Strategy and Targets on the recurrent budget of ACT NOWaste. This is undertaken through a financial assessment of the policy initiatives and consideration of the financial impacts of those initiatives on the ACT Government.

However, the economic impact of ACT waste management policy options on the whole community is also of vital importance to the ACT Government.

Accordingly, the study has investigated both the financial and the economic impacts of some feasible options that the Government may wish to consider in moving forward, and drawn comparisons between those options in terms of the respective financial and economic merit of each.

Six options have been described and modelled, with the first constructed as a "base case" against the remaining five are compared. The six options are set out at Table 1.

Table 1 Feasible Options for Assessing Financial & Economic Impact

Base Case	*Stop Progressing Waste Minimisation & Rely on Landfill.*
Option 1	*Maintain Resource Recovery at Approximately 75%.*
Option 2	*Move Resource Recovery Forward to Approximately 85%.*
Option 3	*Move Resource Recovery Forward to Approximately 90%.*
Option 4	*Move Resource Recovery Forward Beyond 90%.*
Option 5	*Stop Progressing Waste Minimisation & Export Waste to Landfill in NSW.*

In developing the financial models, full system costs and revenues were considered, including an estimate of the likely carbon credits that might accrue for the various initiatives, and the revenues received by the ACT Government from gate fees paid for disposal of waste at landfill from sources other than households.

In developing the economic models, a conventional cost-benefit assessment of economic impacts was developed which incorporates monetary valuations of key impacts, including environmental impacts.

At Table 2 the result of the financial assessment is presented. The data represents 20-year net present value estimates of the incremental difference between each option and the Base Case. The data reflects the incremental financial cost/benefit to the ACT Government and includes consideration of gate fee receipts, impacts of capital costs, and carbon credits for GHG abatement under the initiatives.

Table 2 Incremental Financial Impacts of Options (20-year NPV $mil)

OPTION	COSTS	BENEFITS	NET BENEFIT
Option 1 – hold recovery at 75%	-$3	-$23	-$20
Option 2 – increase recovery to 85%	$21	-$14	-$35
Option 3 – increase recovery to 90%	$1	-$43	-$44
Option 4 – increase recovery beyond 90%	$10	-$72	-$82
Option 5 – cease recovery efforts and export to landfill	-$44	-$157	-$113

At Table 3 the result of the economic assessment is presented. The data represents 20-year net present value estimates of the incremental difference between each option and the Base Case. The data reflects the incremental economic cost/benefit to the wider community and includes consideration of monetary valuations of key impacts, including environmental impacts.

Table 3 Incremental Economic Impacts of Options (20-year NPV $mil)

OPTION	COSTS	BENEFITS	NET BENEFIT
Option 1 – hold recovery at 75%	$56	$55	<$1
Option 2 – increase recovery to 85%	$204	$193	-$10
Option 3 – increase recovery to 90%	$250	$266	$16
Option 4 – increase recovery beyond 90%	$302	$347	$45
Option 5 – cease recovery efforts and export to landfill	$56	$25	-$31

From the financial perspective of the ACT Government the overall cost of waste management will increase as efforts at resource recovery are intensified, due primarily to a dramatic fall in gate fees received as less waste is landfilled and the increasing cost of waste management services.

While from a community perspective, the economic benefit improves as efforts at resource recovery are intensified, due primarily to the reduced environmental impacts as less waste is landfilled.

In addition to the financial and economic impacts set out above, it should be highlighted that there are:

- significant employment benefits created through increasing resource recovery over an economy that relies heavily on land-based disposal of wastes, and
- intergenerational benefits accruing through eliminating disposal of resources to landfill, with commensurate increased demand for replacement resources today, that deny availability of those resources to future generations.

Neither the economic benefit cost analysis nor the financial analysis account for benefits of this nature, yet they represent material and real benefits to society.

Four Additional Recommendations

The ACT Government must know the true cost of landfill disposal of wastes.

In making decisions between resource recovery and disposal it is essential to have a clear understanding of the relative cost of these alternatives.

With land-based disposal the fundamental base option against which all other alternatives are compared, it is recommended that the ACT Government establish a current benchmark, true cost of landfill disposal, and that that benchmark be continually updated.

It is essential to understand the nature of waste streams.

The analytical work undertaken in this study has involved investigating waste reduction and resource recovery initiatives based on the assumed composition of waste streams. In the commercial and construction waste streams the data is not based on rigorous audit or direct measurement. This reduces the credibility of the analyses and it will limit the ability of ACT NOWaste to engage with private sector service providers to invest in infrastructure to target specific waste streams for resource recovery.

It is recommended that adequate provisions be made in future budgets to undertake regular audits and composition studies of the various waste streams.

The ACT kerbside services to the community must be updated.

ACT NOWaste currently delivers kerbside collection services to the community in a two-bin configuration. This has been in place since 1994 and, when introduced, was contemporary and appropriate for the waste management activities that followed collection at that time.

Results from this study indicate that the ACT will fall behind other jurisdictions in both waste management practice and resource recovery outcomes unless the ACT moves to adopting the three-bin collection system that is becoming more common in progressive jurisdictions elsewhere in the country.

It is recommended that the three-bin kerbside collection configuration be implemented across the ACT residential community.

Exporting waste from the ACT is not an option.

The analyses undertaken for this study involve an underlying assumption that the ACT Government continues with the current position where the ACT remains independent of other jurisdictions for the treatment and disposal of waste. However, the option of export of waste for landfill disposal at the Woodlawn facility near Tarago in NSW, instead of landfilling the waste within the ACT was tested as part of the study.

The financial and economic analyses clearly indicate that the net positions under the export assumption are less favourable than that of maintaining the current level of resource recovery and disposing of waste within the ACT. And from a strategic perspective, exporting waste from the ACT for disposal at the Woodlawn facility would place the ACT Government in a difficult financial and tactical position with both the service provider and the community.

It is recommended that export of waste from the ACT not be considered as an option.

Glossary of Terms and Abbreviations

Alternative Waste Technologies (AWT) – a generic term used for waste and resource recovery operations that are deemed to be "alternative" to disposal of wastes at conventional (dry) landfills. Technologies included under this generic term cover processing of both mixed (un-sorted) wastes and source separated (streamed) wastes.

Commercial & Industrial Waste (C&I) – waste streams generated by business activities involving commerce and industry, but excluding building construction.

Construction & Demolition Waste (C&D) – waste streams generated by business activities involving demolition, building, construction and other civil engineering type activities such as road building.

Dirty MRF – a place where discrete materials are recovered from streams of mixed waste that may contain putrescible (organically active) material.

Green (Garden) Waste – typically garden wastes that arise from gardening and lawn maintenance activities. More generally, green or garden wastes form a part of the organic wastes.

Green House Gas (GHG) – the gases present in the earth's atmosphere which reduce the loss of heat into space and therefore contribute to global temperature rise through the greenhouse effect.

Inert Waste – waste that contains no biologically active material that will decompose once landfilled.

Life Cycle Analysis (LCA) – the investigation and valuation of the environmental impacts of a product or service caused by its use and existence, spaning the full life cycle of that item from creations to final disposal or destruction.

Organic Waste – material that is organic in nature and is suitable for biological process treatment such as composting. Typical materials that might be included are garden organic wastes, food wastes, and food-soiled paper. These same materials can be recovered from the C&I waste stream.

Materials Recovery Facility (MRF) – a place where recyclable materials such as those collected from household recycling collections are sorted into separate streams of products.

Putrescible – waste materials that are biologically active and putrefy when left untreated.

Recyclables – the traditional dry materials that are collected in domestic recycling schemes, including paper, cardboard, plastic containers and metal containers. These same materials can be recovered from the C&I waste stream. The term *Dry Recyclables*, when applied to the C&I waste stream, extends beyond the traditional recyclables into other plastics, metals and timber.

Refuse Derived Fuel (RDF) – fuel for combustion-based systems, such as cement kilns and power stations, that is derived from dry materials recovered from waste streams, e.g. timber, soiled paper and cardboard, plastics.

Trash Pack – a hessian bag with approximately 0.5 cubic metres capacity that is supported by a light steel frame. Users may dispose of a range of wastes into these bags, which are collected under commercial arrangements directly between the user and the service provider.

Triple Bottom Line (TBL) – an assessment process that captures an expanded spectrum of values and criteria for measuring organisational and societal success covering economic, environmental and social factors.

1. Introduction

1.1 Purpose

This Report sets out the findings of a review of the ACT No Waste Targets and Strategy established in 1996. The Review is timely given the availability of new waste processing technologies and resource recovery practices, and the outstanding progress made in the ACT toward the goal set more than 10 years ago.

This Review was charged with "providing Government with options for achieving or deferring the No Waste Target within the existing budget constraints".

With the ACT No Waste Strategy at a cross-roads point, it is appropriate to pause and consider the costs and benefits of options for future waste management and their affordability. The Territory, in partnership with the community and business, has already established a commanding position in resource recovery – ahead of all other States and Territories. A logical option, at one extreme, would be to hold the resource recovery effort to the present level. At the other extreme is the public commitment to progress to a position where no waste is sent to landfill.

1.2 Background

The ACT No Waste Strategy was launched with the aim of creating a waste-free community by 2010. The Strategy was based on the idea of engaging citizen and business participation in resource recovery and efficient waste management practices, supported by appropriate pricing and access to waste disposal infrastructure.

In 2005 ACT NOWaste determined that with implementation of programs and alternative waste treatment technologies (AWT), the level of total resource recovery could be lifted to around 95% *which would be a world class result of achieving "No Waste".*

The vision was, and remains, to encourage waste avoidance, to increase the level of resource recovery, to introduce residual waste processing and to eliminate direct disposal of unwanted material to landfill. Most importantly, the ACT No Waste Strategy and Target aimed at reducing the level of dependence on landfill-based disposal, but not eliminating the need for landfill in its entirety.

Numerous reviews of progress and programs within the Strategy have been undertaken, resulting in three-year programs that bring about adjustments to tactics while retaining the broad direction of the No Waste Strategy and retaining the fundamental target.

1.3 Report Structure

This review commences at Chapter 2 with an analytical review of the success to date of the No Waste Strategy. The current waste policy context is described at Chapter 3, with a comparison of waste targets across Australia.

Chapter 4 reports a detailed review of the feasibility of the current No Waste Strategy to actually deliver the No Waste Target based on the content or composition of waste streams currently disposed to landfill.

Chapter 5 establishes a series of options or scenarios that form a basis for financial and economic assessment of the No Waste Strategy and Targets as currently defined, up to an estimated achievable diversion rate of around 85%. That analysis is then extended to consider the merits of an alternative approach to moving beyond the 85% diversion mark, from the approach that is currently proposed in the No Waste Strategy and Targets.

Chapter 6 presents the financial evaluation of a range of policy options that have been configured into a series of logical and sequential options and sets out the relative financial merit of these options in terms of net present valuations over a 20-year period.

Chapter 7 completes the review by presenting a comprehensive economic assessment of the options.

The report is supported by attachments covering notes on the methodology for financial and economic modelling used in the assignment and an overview of the current status of alternative waste technologies.

1.4 Terms of Reference

This study of the ACT No Waste Strategy and Targets was initiated following a Government Review, which found that:

"the goals set out in the No Waste by 2010 strategy developed by the former Government are not achievable within current budget allocations. The Government recognises the achievements of the ACT community and remains committed to reducing landfill waste, but will review targets to an affordable and achievable level."

The deliverables required under this assignment were set out in the Services Agreement and included the following:

(1) The Consultant is required to provide a review of the No Waste Strategy and Targets with a view to providing the Territory with options for

achieving or deferring the targets within the existing budget constraints of the Territory and in accordance with the Services.

(2) The review should not be an analysis of the technological feasibility of achieving the No Waste Strategy. As a basis for the review an analysis of the economic, environmental and social costs and benefits of various options needs to be considered.

(3) Consideration also needs to be given to the political and social acceptability of deferring the No Waste target as well as environmental and financial implications.

(4) A report should clearly detail the anticipated costs associated with the options for achieving or deferring No Waste. A detailed analysis of various options needs to be conducted that includes an examination of the environmental, social and financial impacts of each option.

(5) In the preparation of their report the Consultant shall take into account all relevant information, such as previous reports, progress in other jurisdictions, emerging trends and developments including but not limited to:

   (a) The No Waste by 2010 Strategy document;

   (b) The Commissioner for the Environment's report on implementation of the No Waste Strategy;

   (c) The Actual Costs of Waste Disposal in the ACT;

   (d) The Waste Pricing Strategy for the ACT;

   (e) ACT Government Platform;

   (f) URS, Environment, Social and Financial Review of the No Waste Strategy;

   (g) Turning Waste Into Resources;

   (h) Relevant sections of the ACT Government 2006/07 Budget Papers;

   (i) Waste strategies and achievements in other jurisdictions; and

   (j) National waste initiatives.

Subsequent to the commencement of the assignment two additional tasks were added to the scope and required to form part of the overall project, these were:

- a review of the current status of alternative waste technologies for processing waste streams, and
- review and commentary on the level of domestic kerbside waste collection services that are being rolled-out in other jurisdictions and how the level of services for the ACT community compared.

2. Progress Toward No Waste

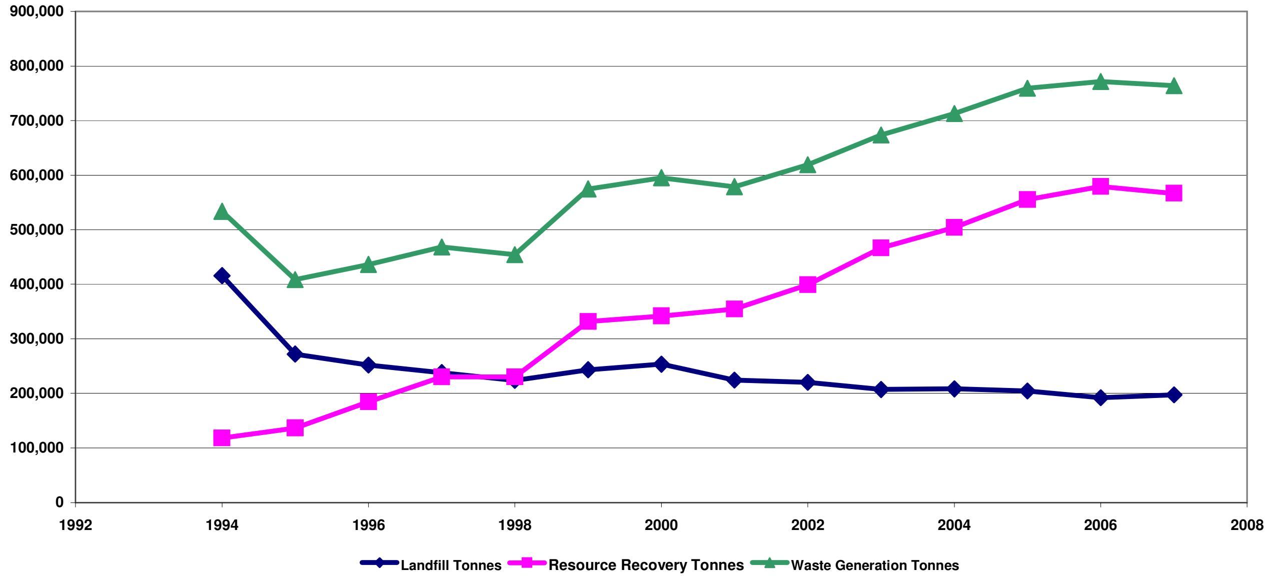
The No Waste strategy has been highly successful in accelerating the recovery of resources that have value, and progressively reducing the amount of waste sent to landfill. The strategy has been supported by the ACT community and has established the Territory as the leading jurisdiction in sustainable waste management in Australia.

2.1 A Report Card on the No Waste Strategy

Progress in resource recovery has been impressive…

The ACT No Waste Strategy has resulted in unprecedented growth in resource recovery – from just 22% of waste generated in 1993/94 to 74% recovery of waste generated in 2006/07. The climb from 51% recovery, when the No Waste Strategy was announced ten years ago, is particularly impressive (see the "Resource Recovery Tonnes" plot at Figure 1). ACT is now well ahead of other jurisdictions in Australia.

Figure 1 Continuous Improvement in Resource Recovery



The big gains have been:

- Garden waste recovery through self-haul and drop off by residents and small businesses – now at 223,000 tonnes compared with 79,000 tonnes when the ACT No Waste Target was introduced.

- Demolition waste, which is now at 182,000 tonnes recovered compared with 89,000 tonnes ten years ago.
- Ferrous metal recovery – increased nine-fold from around 3,500 tonnes to 33,000 tonnes recovered.

Growth in recovery of traditional domestic kerbside recyclables and commercial and industrial waste (C&I) materials has been more modest. There is potential for further big gains in resource recovery here:

- Paper recovery has increased from some 39,000 tonnes to around 49,000 tonnes.
- Plastics recovery has increased from 865 tonnes to 1,427 tonnes.
- Glass recovery is up from 7,200 tonnes to 13,200 tonnes.

Overall, resource recovery at 2006/07 was some 567,000 tonnes or, as noted above, 74% of the 764,000 tonnes of total waste generated. The 12-year history of year-on-year improvements in the amount of resource recovery ended in 2006/07 when a slight decrease in resource recovery was recorded along with an increase in waste to landfill.

…But the amount of waste generated has increased rapidly

The very high level of resource recovery described above has been fuelled by almost equally rapid growth in waste generated. This is a measure of total unwanted materials (waste) created and discarded either for disposal or recovery and recycling. The sum of waste disposed plus recovered resources is the total amount of waste generated by households and businesses.

Waste generation relates directly to consumption of resources and is driven by population increase as well as economic conditions. During the last ten years the amount of waste generated in the ACT increased at an average annual rate of around 6.8% – outstripping both the population growth rate and the growth rate of Gross State Product. The latest data provides encouragement: the waste generation growth rate over the past four years has been +5.8%, +6.5%, +1.6% and -1.0% - with this decline in waste generation in 2006/07 the first time in the past seven years.

…And the amount of waste sent to landfill has (until recently) steadily declined

ACT disposal statistics confirm a progressive reduction in the amount of waste sent to landfill each year since 1994. For the year 2006/07, landfill disposal amounted to around 197,000 tonnes or 26% of the total waste generated.

The "Landfill Tonnes" plot at Figure 1 above clearly shows a dramatic early decrease in the amount of waste presenting for landfill disposal, even as the total amount of waste generated shows strong growth. From those high early gains, disposal has continued to decline, with this encouraging trend continuing through to 2005/06. Unfortunately the trend was halted in 2006/07 with a slight increase in waste disposal, and initial indications from the first half of 2007/08 that this increase in waste disposal is continuing – even in the face of a recently declining amount of total waste generated.

The reasons for the recent change in direction, for both generation rates and disposal, are complex and multiple; however, that data at Figure 1 clearly shows that the amount of resource recovery has fallen more than the fall in the amount of waste being generated, leading to the increase in disposal. This loss of traction in resource recovery has totally negated the recent fall in waste generation.

2.2 Opportunities for Increased Resource Recovery

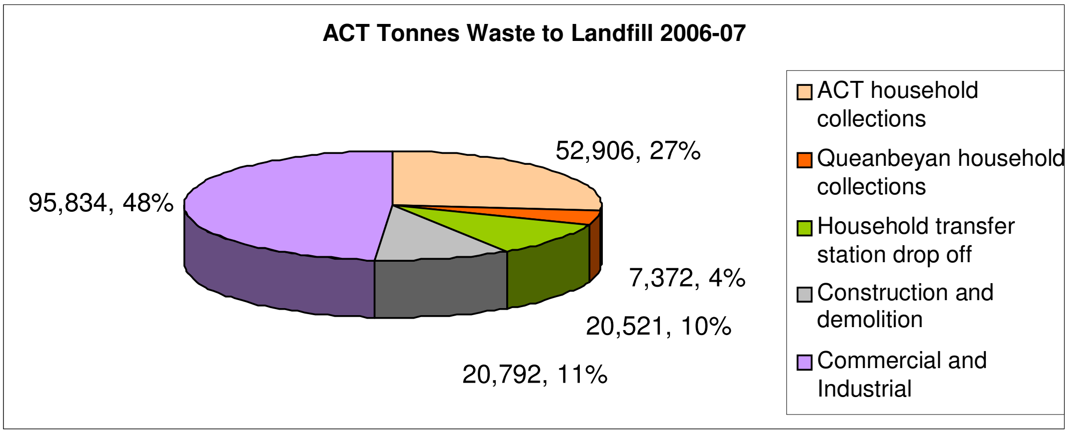
The potential for further gains in resource recovery is a function of:

- the preparedness of the generators to respond to light-handed policy initiatives such as awareness and education programs, partnerships and collaborative programs;
- the composition of the current residual waste stream and consequent opportunities for recovery initiatives;
- the preparedness of waste service providers to change the service mix in line with disposal pricing signals; and
- the technologies and practices in resource recovery and waste processing available, and costs associated with resource recovery.

Data from the ACT No Waste Weighbridge Database on the sources of waste disposed to landfill in the ACT in 2006/07 are shown at Figure 2. This data indicates, and clearly identifies, the ACT business and residential communities as the two groups where targeted initiatives and intervention would have potential to yield further gains in resource recovery.

Inspection of the recovery versus disposal data for the material types referred to above reveals both limitations and opportunities. The C&D sector has responded to the program initiatives and the financial incentive posed by the relatively high landfill gate fee; waste disposed is down to around 10% of waste generated. And the household sector has also performed well in recovering and delivering garden waste – at rates that exceed any other part of Australia. These two sets of materials dominate the waste/recovery streams and maintaining this recovery at current levels will be important but challenging.

Figure 2 Sources of Waste Disposed 2006/07



However, the following opportunities, where resource recovery does not match other jurisdictions, are open for consideration:

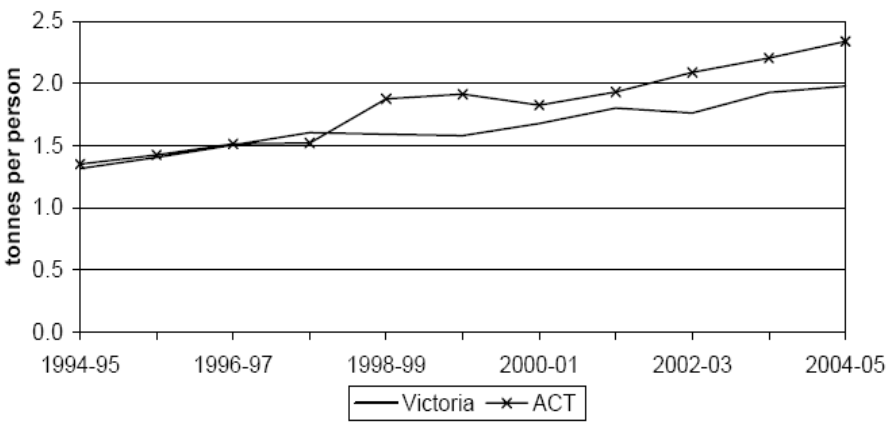
- Improved domestic kerbside recycling where recyclables remain in domestic garbage bins.
- Recovery and recycling of C&I dry materials including paper, cardboard, plastics, timber and metals.
- Recovery of C&I and household food waste with source separation and dedicated collection services.
- Recovery of dry resources and recyclables from C&I and domestic self-haul waste once food waste is removed at source.

3. Current Policy Context

3.1 Trends in Waste Generation

As noted above the pace of increase in waste generated in the ACT during the last ten years has outstripped both local population growth and the growth rate of ACT Gross State Product. And in 2006 the Productivity Commission highlighted that the average growth rate in waste generated per head of population per annum in the ACT is 78 kg per person per year is outpacing that recorded in Victoria where the average generation rate is 60 kg per person per year. This can be seen in the slopes or trends for the data in Figure 3.

Figure 3 **Waste generation in Victoria and the ACT[a]**



Growing amounts of waste generated pose a complex challenge for waste authorities:

- the most pressing demand is to magnify resource recovery efforts in order to both recover an appropriate portion of the newly created material, and to cost-effectively increase recovery from the base waste stream;
- this inevitably results in rapidly escalating resource recovery operating and capital costs for industry, and increased management and program costs for waste service administrators;
- the penalty for faltering resource recovery effort in the face of increasing waste generation is increased waste disposal cost, foregone opportunity for resource capture, increased greenhouse gas emissions, and pressure on available landfill capacity.

To date, efforts at community education in most jurisdictions to reduce the amount of waste generated in the first instance have been less than successful. Waste generation remains aligned with growth in prosperity.

3.2 National Waste Management Comparisons

Wide variations exist in the waste reduction targets set by governments across Australia and in other developed countries. Three styles of targets can be discerned:

- aspirational targets, such as no waste directly to landfill (ACT Australia);
- environment protection targets, such as Germany's requirement that (from 2005) waste must be treated prior to landfill disposal; and
- functional targets, adopted by the majority of jurisdictions and based usually on a reasonably achievable stretch from current performance, but without necessarily any justification for the absolute numerical value of the target, e.g. 66% diversion of domestic waste from landfill by 2014 in NSW.

Approaches to target setting and resource recovery management appear to reflect a combination of government determination and an understanding of citizen and business willingness to participate in recycling and resource recovery. There is no established best practice in either policy position, target setting or the management of waste and recovery of resources.

A variety of approaches have been established by the jurisdictions. Importantly, four jurisdictions (ACT, Victoria, SA and WA) now have policy positions that embody an aspirational objective of moving towards zero waste, with underlying physical targets to support monitoring of progress:

- in WA the focus is on measuring performance in resource recovery for specific materials (timber, organics, recyclables);
- in SA there is a specific target for domestic waste resource recovery, but for C&I and C&D waste streams the aim is to measure the extent of improvement in resource recovery, rather than the absolute recovery level;
- in Victoria, overall goals are established for each of the three traditional waste sectors, and
- in the ACT, performance monitoring has been targeted at the total waste system performance.

NSW has sectoral targets, in line with Victoria, but does not have any overarching aspirational policy objective. Thus far, NT, Queensland and Tasmania are yet to establish either aspirational policy objectives or physical targets for resource recovery. It is understood that both Tasmania and Queensland are reviewing that position.

The target settings for the four states (NSW, Vic, SA and WA) are outlined in Table 4 below.

Table 4 Targets Developed in Australian States

WASTE STREAM	**NSW**	**VIC**	**SA**	**WA**
DOMESTIC	66% recovery by 2014	65% recovery by 2014	75% recovery (including food waste) by 2014	Recovery targets to be achieved by 2015 focus on waste types rather than sources: ***Inert*** (mainly C&D) 100% ***Organics*** (domestic and commercial) 85% ***Recyclables*** (kerbside) 100%
C&I	63% recovery by 2014	80% recovery by 2014	30% increase in recovery (over 2004 tonnage) by 2010	
C&D	76% recovery by 2014	80% recovery by 2014	50% increase in recovery (over 2004 tonnage) by 2010	

Source: Data drawn from Department of Environment & Climate Change, NSW. *Draft NSW Waste Avoidance & Resource Recovery Strategy 2006/07.*

The target of the ACT No Waste Strategy is the aspirational leader, just ahead of WA. The stretch target may inspire resource recovery performance: it is notable that ACT comfortably leads the other Australian States in the achieved level of resource recovery. For instance, NSW and Victoria are currently achieving around 45% - 50% resource recovery compared with 74% for ACT during 2006/07.

Canberra citizens and business undertakings may have taken up the challenge of the aspirational No Waste target, or they may simply be better recyclers and conservationists of certain materials. Whichever is correct, it is clear that, while further significant opportunities exist for resource recovery, the ACT target and resource recovery performance to date set an example of sustainable waste management.

This leadership position of the ACT is however neither guaranteed nor can it be taken for granted. Victoria and South Australia have ambitious and well-funded programs to address both waste generation and resource recovery, with multiple intervention initiatives that are being rapidly implemented. As these programs gain traction in those jurisdictions the resource recovery leadership position rankings could also change with the leader's baton rapidly snatched from the ACT if the ACT loses ground.

3.3 International Waste Management Comparisons

In Europe, the EU is setting the pace in performance targets for Member States. However, within the Member States there are some individual differences in sub-elements of their respective waste reduction initiatives and targets. At Table 5 below, the objective for the EU is summarised and specific variances are shown for France and Germany respectively.

Table 5 Targets Adopted in Europe for Domestic Waste

EU Generally	GERMANY	FRANCE
Progressively reduce the amount of biodegradable waste to landfills: 75% of 1995 level by 2006 50% of 1995 level by 2009 25% of 1995 level by 2016	From 2005, all waste to be landfilled must be treated*. **Note:** Germany has separate food waste collection and treatment services.	From 2002, only non-reusable, non-recyclable and non-dangerous wastes can be disposed to landfill.

*__Note:__ The term "treated" means that biologically active material is stabilised before landfilling to reduce biodegradation in the landfill.

Source: Compiled by WCS from various sources.

3.4 Technology Availability for Resource Recovery

Material Recovery Facilities

The main focus of technology development in Australia over the last 15 years has been the progressive refinement of Material Recovery Facilities (MRFs). Used initially for sorting, separating and reprocessing dry recyclable materials, such as kerbside collected household recyclables, MRFs have reached a high level of sophistication. The sorting and separating systems used successfully in MRFs have been extended to resource recovery from business waste – initially for dry materials, such as plastics, timber, metals and glass – again, with considerable success.

More recently, *Dirty MRFs* are being introduced to sort and recover recyclable and recoverable materials from essentially dry waste streams that have been separated at source from the wet, or putrescible fraction of waste. The dry streams lend themselves to manual and mechanical sorting to deliver higher levels of resource recovery than is possible with fully mixed wet waste streams. This Dirty MRF approach can also be used for resource recovery from transfer station waste streams and from the self-haul drop-off waste stream from the residential community.

Alternative Waste Technologies

Alternative Waste Technology (AWT) is the generic term used for waste and resource recovery operations that are deemed to be "alternative" to disposal of wastes at conventional landfills. Therefore, in this regard, AWT is intended to cover the full spectrum of alternative options for resource recovery and residuals disposal.

A mix of AWTs has been introduced to Australia in recent years with much promise, but mixed success. AWTs are more widely used in Europe in response to prohibitive landfill costs for unstabilised material and recent regulations limiting disposal to landfill of organic material or requiring treatment and stabilisation of waste prior to landfill disposal.

In essence, AWT process options are implemented because the option of not disposing of wastes to land-based systems is more attractive, in terms of social, environmental and/or financial considerations, than disposing the wastes at landfill.

Attachment 2 to this report provides a briefing on the following aspects of AWT:

- an overview of AWT technologies and practices in Australia;
- comparisons on the operations of existing AWT facilities in Australia;
- a broad overview of the wider AWT systems and their application overseas;
- considerations in evaluating AWT options; and
- the international context for AWT.

Waste treatment costs using the main emerging technologies with source separated food waste or mixed waste feedstock to produce beneficial products are in the range of $90 to $130 per tonne of waste input. This is comparable to landfill costs in ACT and Sydney, but more costly than landfilling in other states.

Australia has a handful of companies able to offer systems for waste processing. Around ten AWT facilities are currently in use in Australia. At least six more are in construction or at the public assessment stage.

AWTs have reached varying stages of commercial maturity. Many of the emerging technology types excel at processing specific, streamed waste of a fairly consistent nature. Waste streaming at the point of discard (source separation), and subsequent processing using appropriate technologies, can produce high quality product that readily command markets. Streaming at source, however, is not always feasible from a social or financial viewpoint. For strategic management of waste, therefore, successful processing of mixed residual waste to create quality compost and recyclable materials is an important goal across the waste industry.

In 2005 ACT NOWaste determined that with implementation of programs and mixed waste AWT processing, the level of total resource recovery could be lifted to around 95% which would be a world class result of achieving "No Waste".

At that time there was no compelling evidence of the success of AWT with mixed waste streams, however, it was suggested that perhaps by 2007, there may be better evidence upon which to consider AWT for future implementation. That thinking was based on doubts about whether the technologies would, after a period of commercial application, reach a level of maturity suitable for mixed waste processing that could be harnessed to eliminate the need for direct disposal of wastes to landfill – i.e. that those technologies had demonstrated reasonable capacity to deliver on resource recovery promises.

From the material presented in Attachment 2 it is reasonable to summarise that:

- ✓ AWT as applied to source separated materials such as organic and construction wastes comprise well-proven and viable technologies that are in successful operation in many cities and towns around Australia and elsewhere overseas.
- ✓ With the exception of a limited amount of residual waste stabilisation at Hastings, mixed waste AWT is not used in Australia as a pre-landfill stabilising technology.
- ✓ AWT for recovery of saleable resources from mixed residual waste remains an emerging technology in Australia. Aside from land remediation of degraded sites, the technology is still to be reliably and independently verified to deliver sustainable and significant reductions in waste to landfill and products that are readily saleable on diverse and robust markets. At this stage, mixed waste processing AWT systems cannot be considered as commercially proven.

The critical dependence of ACT No Waste Strategy and Targets to achieve the No Waste target of 95% by 2010 cannot be supported by current technologies for mixed waste processing. It is therefore timely to review the underlying technologies on which future strategy and policy will rely.

4. Feasibility of Existing Waste Targets

4.1 Summary

Any critical review of the ACT No Waste Strategy and Targets must contain an independent analysis of whether the strategy will, in fact, deliver the targeted outcomes. This Chapter involves a brief review of the initiatives contained in the No Waste Strategy, and testing the feasibility of the initiatives and technologies proposed to enable the No Waste Targets to be met.

4.2 Defining the Existing No Waste Strategy Approach

The most recent public statement of the proposed suite of initiatives of the No Waste Strategy appears in the ACT Government publication *Your Guide to becoming a No Waste household,* released in 2005, and was based on 2003/04 waste data when resource recovery was at 70%.

This document set out the specific initiatives intended to increase resource recovery and quantified the outcomes expected from those initiatives. The document - *Your Guide to becoming a No Waste household* – was incorporated within the 2004-2007 three-year action plan titled Turning Waste Into Resources.

This review is timely because although the initiatives implemented over the last few years pushed up the level of resource recovery to 75% in 2005/06, the recovery level slipped slightly to 74% in 2006/07. This slip in resource recovery was accompanied by an increase in the amount of waste to landfill for the first time in some years to 197,000 tonnes in 2006/07 – at the same time that a slight fall was recorded in the total amount of waste generated.

Data on waste disposal rates for the first six months of the 2007/08 financial year indicate that landfilling could be in target to reach over 210,000 tonnes in this year – a level not seen since 2002/03. In the absence of data on resource recovery and total waste generated, it is not reasonable to reflect on possible underlying causes for this apparent regression.

At 2005, the plan to move from 70% resource recovery to 95% was established by ACT NOWaste, with seven nominated initiatives, as shown in Table 6.

Table 6 Existing No Waste Strategy Beyond 70% Resource Recovery (as at 2005)

Domestic Waste (household) Sector:	
	5,000 tonnes, additional kerbside recycling.
	7,000 tonnes, additional green waste capture/home composting.
Commercial and Industrial (C&I) Sector	
	50,000 tonnes, additional recyclable materials.
	15,000 tonnes, organic materials processing.
Construction and Demolition (C&D) Sector	
	3,000 tonnes, timber waste recovery.
	23,000 tonnes, construction and demolition recovery.
Domestic and C&I Sectors	
	Mixed waste AWT processing to divert a further 50,000 tonnes from landfill.

Source: ACT NOWaste *Your Guide to becoming a No Waste household,* 2005.

4.3 Review of the Existing No Waste Initiatives

In the following section, each of the elements proposed in the strategy is taken and tested for reasonableness against the apparent amount of material remaining in the waste stream going to landfill and the cost effective availability of technology to undertake the intended recovery.

Until late 2007, there was scant reliable data on the true composition of commercial and industrial waste going to landfill, and the strategy was based on estimates of commercial waste composition dating from the mid-1990's.

In response to this review, efforts were made by TAMS staff to determine more closely the composition of the commercial discard stream. That data, based on reports from various service providers, informs this review and renders the following analysis more likely to reflect the current situation. It is however, thought likely that this additional information on waste composition is only based on visual observations of the various service providers of the material recovered and the residual materials disposed. Historically visual observations of waste may be unreliable and is not a sound basis for deciding on appropriate initiatives that require investment from either or both the public and private sectors.

Detailed and independent audits remain to be undertaken, and commercial waste composition remains a significant information gap. It is therefore essential that the actual composition of waste streams be clearly understood as a precursor to any attempts to analyse opportunities for further resource recovery initiatives. On-going physical audits of the various waste streams must be a regular part of future programs to inform decision-making and to provide material that supports initiatives and investments by waste service providers and the Government.

Domestic Waste (household) Sector

		Tonnes	Percent
Data on Domestic Waste for 2006/07: (Source: ACT NoWaste)	***Generated***	268,163	100%
	Recovered	182,992	68%
	Disposed	85,171	32%

Kerbside recycling. The latest waste audit indicates a kerbside recycling recovery rate of 65.1% of the available recyclables. This is in line with other jurisdictions, but falls short of achieved recovery rates in some local government areas. For example, in 2004 Baulkham Hills (a Sydney suburb) recorded a 73.9% recycling recovery rate for a population of around 300,000.

Thus, it would appear that there is some scope for increased household recyclables separation and presentation. The proposed 5,000 additional tonnes of kerbside recyclables recovery should be feasible with an enriched program promoting increased recycling, with some extra costs in program and promotional costs but no significant additional cost in services or infrastructure.

Green waste capture and home composting. Canberra outstrips every other Australian city in the amount of source separated self-hauled green waste delivered for processing. Estimated green waste recovery for 2006/07 was more than 220,000 tonnes, up from 208,000 tonnes in 2005/06. Substantial further contributions are unlikely, but a modest increase may be possible from residential drop-off, skip bins and trash packs.

For commercial garden maintenance operators, there is a significant price incentive against landfill disposal of green waste, given that free drop-off is also made available to this sector.

The Productivity Commission report into Waste Management in 2006 referred to ABS data indicating that home composting performance in the ACT is already high compared with other States (81% of ACT households practice composting, compared with 46% of Australian households).

On this basis, the proposed modest diversion of an additional 7,000 tonnes/year of green waste through some small increase in both drop-off and home composting appears feasible, provided additional education, resource support and information programs are funded.

Commercial and Industrial (C&I) Sector

		Tonnes	Percent
Data on C&I Waste for 2006/07: (Source: ACT NoWaste)	**Generated**	292,205	100%
	Recovered	200,742	69%
	Disposed	91,463	31%

C&I recycling. Initiatives over the past few years appear to have reduced to around 41,000 tonnes the amount of readily available and recyclable C&I dry material (paper/cardboard; glass, plastics and metals; and wood/timber), which obviously does not match the further 50,000 tonnes proposed in the strategy.

With recovery at approximately 31% from the C&I sector, there is considerable scope for increased recycling.

The proportion of food waste and garden waste in the C&I discard mix appears to have increased over recent years, based on the recent waste composition information from service providers. This fraction therefore becomes an obvious target in lieu of the extra dry recyclable materials (see Table 7).

Potentially recyclable C&I dry material such as paper and cardboard comprise some 26,500 tonnes a year in the discard to landfill. While a further 8,700 tonnes of potentially recyclable glass, soft plastics and metals and 6,000 tonnes of timber could be available.

Table 7 Estimated Composition of C&I Waste to Landfill (2006/07)

MATERIALS	TONNES	PERCENT
Paper & cardboard	26,500	30%
Food and garden waste	37,900	42%
Glass, hard & soft plastics, metals	8,700	10%
Wood & timber	6,000	7%
Other	12,400	11%
Total	**91,500**	**100%**

On the basis of the proposed 75% recovery of dry C&I recyclables at the time the Strategy – *"Turning Waste into Resources"* – was developed, and in keeping with the C&I recovery targets adopted by other States, it is reasonable to assume that around 60% of dry C&I recyclable materials might be recovered. This equates to some 30,000 tonnes of additional dry resource recovery from the C&I sector. This would be mostly paper supplemented by some timber and commercial plastics.

This material is likely to be recovered through a combination of source separation followed by separate drop-off, and resource recovery in a dry waste Dirty MRF.

C&I organic materials recovery. Some 33,000 tonnes/year of C&I food waste and nearly 4,900 tonnes of garden waste are sent to landfill and are potentially available for recovery and processing. Scope to capture considerably more than the 15,000 tonnes/year proposed in the Strategy is considered feasible and would make a valuable contribution to greenhouse gas reduction efforts in the Territory. The actual level of recovery would be dependent on ACT willingness to implement aggressive policy settings to discourage disposal of C&I organics and encourage source separation of these materials. Recovery of 25,000 tonnes per year would form a viable feedstock for an organics-only AWT facility such as a Vertical Composting Unit. Viable compost products can be created using streamed food waste and garden waste feedstock.

Construction and Demolition (C&D) Sector

Data on C&D Waste for 2006/07:
(Source: ACT NoWaste)

	Tonnes	***Percent***
Generated	203,690	100%
Recovered	182,898	90%
Disposed	20,792	10%

C&D timber recycling. The proposed 3,000 tonnes of timber waste appears to be around the limit of feasibility as there appears to be less than 6,000 tonnes of timber materials available in both the combined C&D and C&I sectors. Given the already high level of resource recovery in the C&D sector, further recovery action for this material may need to take place at landfill-based resource recovery facilities. The No Waste Strategy proposes source separation of recoverable material, with the benefit of reduced landfill gate fees.

C&D waste. Inroads have already been made into the proposed capture of a further 23,000 tonnes of C&D waste.

Currently some 20,000 tonnes of material are disposed to landfill from the C&D sector representing waste disposal rate around 10% of waste generated.

On this basis, it is estimated that a maximum of 6,000 tonnes/year of additional suitable material could be recovered in the next round of initiatives.

AWT Processing of Domestic and C&I Mixed Waste

The Strategy also proposed AWT processing of mixed waste sourced from the domestic and C&I sectors.

Domestic mixed residual waste. Three streams of domestic residual waste are available for consideration: kerbside collected waste from ACT; self-haul delivery; and Queanbeyan domestic collected waste.

The APrince Consulting 2004 Waste Audit for ACT NOWaste indicated that at least 50% of the material in the ACT kerbside collected domestic waste stream was either food or vegetation, which, when combined with other compostable materials in this waste stream, represents a relatively organic-rich feedstock for a mixed waste AWT. In 2006/07 the ACT kerbside collected domestic waste stream amounted to some 57,300 tonnes going to landfill.

However, assuming the initiatives discussed above to increase resource recovery are funded and implemented, the residual waste stream would be reduced by some 12,000 tonnes through those initiatives (5,000 tonnes of additional kerbside recycling and 7,000 tonnes of green waste converted to home composting). This leaves a mixed residual waste stream from the ACT kerbside collected domestic waste of 45,300 tonnes per annum available for AWT feedstock.

The Queanbeyan domestic kerbside collected waste amounted to 7,300 tonnes in 2006/07 and is likely to contain a similar proportion of organic material to the ACT domestic waste.

Of the 20,500 tonnes of self-hauled domestic waste delivered to transfer stations and landfill in 2006/07, the vast majority is unlikely to have sufficient organic and compostable content to be suitable for inclusion in an AWT feedstock. A conservative 15% of this waste stream is assumed to be suitable for AWT processing (3,000 tonnes per annum). A proportion of the remaining (non-organic) material may be suited to refuse derived fuel (RDF) manufacture at a future date, and could typically be recovered in a Dirty MRF facility.

C&I mixed residual waste. The C&I organic materials recovery initiative described at Section 4.2 above would deplete up to 70% of organic material from the C&I mixed waste stream, rendering the remaining fraction of waste stream only marginally suitable for mixed waste AWT processing.

On this, it is not considered either feasible or cost effective for the remaining C&I waste stream to be a feedstock for processing in a mixed waste AWT.

As is the case for the self-haul domestic waste, a proportion of the remaining (non-organic) material may be suited to refuse derived fuels at a future date, and could be recovered through a Dirty MRF facility.

Summary of Possible Mixed Waste AWT Operation. The total waste that might be suitable and streamed into an AWT facility as feedstock based on the above analysis is therefore in the order of 55,600 tonnes per annum of relatively high organic content materials:

- 45,300 tonnes from the ACT kerbside collected domestic stream,
- 3,000 tonnes from domestic self-haul drop-off, and
- 7,300 tonnes from the Queanbeyan kerbside collected domestic stream.
- Zero tonnes from C&I residual waste (due to the depleted organic content from earlier initiatives).

Processing this 55,600 tonnes of feedstock might, at best, result in recovery of 40% of the feedstock (30 percentage points of compost and 10 percentage points of recyclable metals, paper and plastics). There would be around 25% loss of feedstock mass through moisture loss during processing, and around 35% of the feedstock would be residual material for disposal. Thus, it is possible that at best 65% of the feedstock material or some 36,000 tonnes might be diverted from landfill based on 2006/07 waste data.

4.4 Findings

This review has shown that the No Waste Strategy appropriately targets waste streams of significance that continue to be sent to landfill rather than recovery. It is difficult to argue with the focus of attention in the strategy, and implementation schemes are readily identifiable. However, the limited success in reducing the amount of dry recyclable C&I waste sent to landfill is noteworthy, as is the apparent increase in the amount of C&I food waste generated.

Clear opportunities with commercial merit remain to increase the recovery achieved from the C&I sector and, to a lesser extent, the C&D sector. The No Waste Strategy has targeted the substantial amounts of dry resources generated by these sectors. This makes good sense because these materials can be handled and sorted at low cost yet presently consume valuable landfill space.

There is also scope to capture additional domestic sector recycling materials through improved participation in kerbside recycling. The marginal cost of promoting the importance of increasing kerbside recycling is modest, yet the payoff in terms of landfill space saved and additional valuable resource recovery is important.

The attainment of *No Waste* or a 95% diversion from landfill, is not possible under the current policy approach.

From this analysis, the estimated diversion of waste from landfill that might be possible by continuing to implement the existing No Waste Strategy initiatives is set out at Table 8 and compared with expectations from 2005.

Table 8 Scope for Further Diversion from Landfill Under the Existing Strategy and Initiatives

	Estimated Diversion		2005 Target Diversion	
	Tonnes pa	%*	Tonnes pa	%*
Domestic Waste (household) Sector:				
kerbside recycling	5,000	76%	5,000	76%
green waste/home composting	7,000	77%	7,000	77%
Commercial and Industrial (C&I) Sector:				
dry recyclable materials	30,000	80%	50,000	83%
organic materials processing	25,000	84%	15,000	85%
Construction and Demolition (C&D) Sector:				
timber waste recovery	3,000	84%	3,000	85%
C&D recovery	6,000	85%	23,000	88%
Domestic and C&I Sectors:				
mixed waste AWT processing	36,000	90%	50,000	95%
Total Further Diversion	**112,000**		**153,000**	

Source: ACT NOWaste *Your Guide to becoming a No Waste household,* 2005.

***Note**: the percentage reported is the cumulative percent of further diversion beyond the 75% achieved to 2005.

It is essential to understand the nature of waste streams.

The analytical work undertaken in this section has involved investigating waste reduction and resource recovery initiatives currently proposed in the ACT No Waste Strategy and Targets. The analysis has been from the perspective of assessing the reasonableness or likelihood that the proposed resource recovery initiatives and technology options selected can extract the targeted materials from the waste stream.

An essential starting point for this type of analysis is a clear understanding of the nature and composition of the waste stream being addressed. For the domestic waste stream, ACT NOWaste has reasonable, current audit data that permits this analytical approach to have a solid foundation.

However, in the other waste streams, C&I and C&D, the data is limited and not based on rigorous audit or direct measurement. This will reduce the credibility of the analyses carried out on these waste streams at this point in time and it will limit the ability of ACT NOWaste to engage in meaningful discussions with private sector service providers on investing in infrastructure to target specific waste streams for resource recovery.

In the foregoing analyses, and using the available knowledge on waste stream compositions, there would not appear to be sufficient target materials in the respective waste streams to deliver on the strategy and targets as envisaged in 2005 and using the technologies considered appropriate at that time.

It is strongly recommended that adequate provisions be made in future budgets to undertake regular audits and composition studies of the various waste streams. And it is further recommended that the audits for individual waste streams be repeated on a regular (minimum every 3 years) basis to ensure that the changing nature and composition of waste streams is fully comprehended.

It is essential to have technologies and practices that can deliver.

In respect of the technology considered to be appropriate for processing the residual waste stream – mixed waste AWT processing – the analyses has found that there is insufficient target materials entrained in the residual waste stream to achieve the intended target. In addition, the review of alternative waste processing technologies in the previous section, cast reasonable doubt on the performance capability of mixed waste processing technologies to deliver quality products at affordable cost with an acceptable level of risk for the ACT Government.

The technology intended does not match the waste stream that is likely to be remaining, and cannot, at this stage be relied upon to deliver the desired diversion target.

On this basis, the current No Waste Strategy and Targets is considered to be unachievable under the scenario proposed in 2005 and with the waste streams thought to be available today.

A new approach will need to be developed embracing a mix of intervention possibilities that cover regulation, pricing and education. And an alternative approach to technology selection will need to be developed to manage the residual fraction of waste streams if resource recovery beyond 85% is to be considered.

5. A Basis for Financial and Economic Assessment

5.1 Introduction

The analysis at Section 4 clearly indicated that both the technology selection and the composition of the waste stream, as currently understood, present major impediments to the No Waste Strategy and Targets, to the extent that the No Waste Strategy and Targets cannot be achieved as presently configured.

The analysis does however demonstrate that continuing resource recovery beyond the (2005) 75% diversion rate is feasible and very reasonable at least to the level of 85% diversion, using currently available and commercially operating waste technologies and practices.

Therefore, to establish a basis for investigating the financial and economic benefits of increasing resource recovery and continuing to divert waste from landfill as envisaged in the No Waste Strategy and Targets, Wright Corporate Strategy developed a series of scenarios or options that would see:

- progression of diversion from 75% through the 85% level using technologies and initiatives as proposed in the No Waste Strategy and Targets, then
- progression to 90% and beyond based on managing the current waste stream with contemporary practices and technologies that are beginning introduced on other jurisdictions.

In developing options for moving beyond 85% diversion, it was necessary to look at both technologies that might be available and the waste services that go with those technologies.

5.2 Directions in Technology and Practice

In a number of jurisdictions, the view has been formed that mixed waste processing technology does not offer the immediate potential for high-level beneficial recovery of resources from the waste stream that communities are seeking. Accordingly, as explained in the review of AWT systems at Attachment 2, there is increasing interest being shown in processing un-contaminated streams of organic materials in dedicated composting systems.

Harnessing this technology approach introduces a number of consequential issues and opportunities that need to be considered, including:

- to secure supplies of un-contaminated streams of organic material it is essential to implement measures to have waste generators source separate organic and food waste from the other, essentially dry, wastes;
- following source separation, dedicated collections are separately required for the organic (wet) and essentially inorganic (dry) streams; and
- the dry streams present an opportunity for additional resource recovery using relatively low cost sorting technologies, without the environmental and occupational health and safety challenges associated with handling mixed waste streams.

In the domestic sector, the practice of source separation of food organics is gaining increased support across Australia, and the ACT is certainly lagging other jurisdictions in the implementation of a third bin for the collection of the garden organic fraction from households. Once introduced for garden organics, a third bin is available to be morphed from garden organics only to a food and garden organics collection service once the community is prepared and the technology system in place. This issue is discussed further below.

For the C&I sector, policy and financial settings are required to encourage the source separation of organic waste from the other wastes, and some initiatives developed to encourage the waste collection contractors to provide additional services dedicated to source separated organics.

Once the streams of un-contaminated organic wastes are assured, business interests could then be encouraged to invest the required capital in organic waste AWT composting facilities, on the basis of a reasonable expectation of clean organic wastes being received, leaving the ACT Government free from capital investment obligations in establishing this infrastructure.

The benefits from this change in managing business waste are significant, in particular through the access that is gained to relatively large quantities of dry materials that can be recovered at relatively low cost for beneficial reuse using Dirty MRF sorting and the upgrading of existing transfer/MRF facilities for processing and resource recovery.

With Dirty MRF sorting in place, it is common today to see self-haul drop-off domestic wastes, which are essentially free of putrescible material, directed to the Dirty MRF for resource recovery in addition to the dry C&I waste – an approach that is already being undertaken in the ACT.

As with the dedicated processing of organic waste streams, introduction of Dirty MRF sorting could be readily underwritten by the private sector if appropriate policy and pricing incentives are established, and access to the waste streams reasonably assured.

Beyond the dedicated processing or organic waste and Dirty MRF sorting of dry waste, it could be feasible to add a form of AWT facility to process the residual waste and render it inert prior to placement in landfill. This option is currently undertaken in many European centres, however, this is a costly initiative and, aside from GHG abatement, may be of limited value.

5.3 Domestic Collection Services

In considering practices and technologies that might be suitable for moving forward, it is worthwhile to consider where the ACT community sits in terms of service levels and service costs relative to communities elsewhere in the country, and what the full system costs might be for these alternatives.

Whilst the ACT has been a service-leader, and currently holds the leadership position for total resource recovery from the waste stream, the ACT is slipping behind other jurisdictions in terms of kerbside service levels to the community.

The current collection format has been in place since 1994. When introduced, it was contemporary and appropriate for the waste management activities that followed collection at that time. However it is now dated and well behind the collection systems that are being introduced elsewhere. And, there is evidence that other communities are prepared to pay considerably more for their kerbside services than is currently asked of the ACT community.

Given the slippage noted in resource recovery over the past 18 months and an increase in disposal to landfill for the first time in many years, it is clear that if the ACT wants to continue ahead of other jurisdictions, then a fresh approach needs to be considered in respect of domestic waste.

To develop the evidence base that supports this view, staff of TAMS liased with colleagues in various waste management agencies in other jurisdictions and assembled the data presented at Table 9.

The aims of this survey were three-fold:

- firstly, to understand the direction that is being pursued in other jurisdictions in respect of waste processing technologies employed to recover valuable resources from the domestic waste stream and reduce demand on landfill;
- secondly, to understand the practice consequences in the household and at kerbside that arise as a result of those technology selections; and
- thirdly, to understand the consequences in terms of costs for kerbside services that those communities have to pay.

Table 9 Kerbside Waste Collection Systems - Major Metropolitan Councils, Australia

JURISDICTION	ACT	NSW	VIC	QLD	WA	SA
No of Councils	1	21	31	13	3 (30 Metro)	16
No of Councils with 3 Bin System	0	13	30 – 3rd bin mostly optional	0	0 major 2 metro: Bayswater (pop 55,801 and Nedlands (pop 21,803)	14
Description of other systems in use	2 bin: garbage & recycling	2 = 4 bin: garbage, 2 recycling & green waste. 5 = 2 bin: garbage & recycling.	Melbourne CBD = 2 bin: garbage & recycling	12 = 2 bin: garbage & recycling. 1 = split bin: garbage & recycling	Most metro councils have or are moving towards 2 bin: garbage & recycling	2 bin: split bin (garbage & recycling) and green waste bin
Councils collecting organics (food)	0	Port Mcquarie and Coffs Harbour	Nillumbik Shire State Gov currently investigating needs for development of organics industry with an aim of moving towards organics collection.	Council amalgamations have limiting progress until after March 2008 with a number of councils considering implementing 3rd bin services.	None collect source-separated food waste. WA has a number of AWTs built and planned, which recover organic material from the mixed waste stream.0	State Gov (Zero Waste SA) planning to facilitate roll-out of organics collection in 2008.
Councils trialling organics (food) collection	Chifley Trial August 2000- June 2001	Leichhardt successful and complete 2007	Moonee Valley City Council	0	0	Burnside successful and complete 2007

JURISDICTION	ACT	NSW	VIC	QLD	WA	SA
Direct average cost per rateable property per annum for provision of the most common system including disposal	$112 Including disposal	$166 - $504 (3 bin system)	$100 (2 bin) $120 (3 bin) Including disposal	$170-$180 Including disposal	$160 - $175 (3 bin system) Including disposal	$118 - $120 Including disposal (approx $25 landfill disposal)
Direct average cost per rateable property per annum not including disposal	$73 Not including disposal	Not available	$79 - $99 Not including disposal	Not available	Not available	$93 - $95 Not including disposal

The data at Table 9 clearly demonstrates that, while the ACT community enjoys a relatively low cost service regime, the progress being made in other jurisdictions towards introducing efforts to recover organic materials from the domestic waste stream is certainly out-pacing that of the ACT.

If a similar move is made in the ACT, then dedicated processing of streams of uncontaminated organic wastes from the domestic sector could be introduced.

5.4 Possible Steps for Further Resource Recovery

For the purposes of the financial and economic analysis, it is necessary to start with a Base Case framed around a feasible scenario that may be chosen, against which the alternative options for moving forward can be compared.

In this study, the Base Case has been taken to be a situation where on-going efforts to continue growing resource recovery outcomes, in the face of increasing waste generation rates, ceases, and the actual resource recovery rate recedes as generation growth outpaces the gains made to date.

From the Base Case, a series of logical and achievable sequential scenarios or options are set out below, commencing with the steps articulated in the No Waste Strategy then moving beyond an 85% diversion rate assuming the alternative approach to technologies and practices discussed earlier.

- *Base Case – Stop Progressing Waste Minimisation & Rely on Landfill*. With increasing growth in generation and diminishing waste minimisation resource recovery levels taper off dramatically to pre-1998 levels

- *Option 1 – Maintain Resource Recovery at Approximately 75%*. On a zero waste generation growth rate, this requires a further recovery of 6,400 (approx) tonnes per year over the Base Case. With growth in waste generation, additional efforts at resource recovery will be required to combat growth and maintain 75% in the long-term.

- *Option 2 – Move Resource Recovery Forward to Approximately 85%.* On a zero waste generation growth rate, this requires a further recovery of 82,400 (approx) tonnes per year over the Base Case (net increase of 76,000 tonnes per year over Option 1). To achieve this Option, processing of source separated organic wastes will need to be introduced. With growth in waste generation, additional efforts at resource recovery will be required to combat growth and maintain 85% in the long-term.

- *Option 3 – Move Resource Recovery Forward to Approximately 90%.* On a zero waste generation growth rate, this requires a further recovery of 125,900 (approx) tonnes per year over the Base Case (net increase of around 43,500 tonnes per year over Option 2). To achieve this Option, processing of source separated organic wastes from the commercial sector will need to be stepped up considerably. With growth in waste generation, additional efforts at resource recovery will be required to combat growth and maintain 90% in the long-term.

- *Option 4 – Move Resource Recovery Forward Beyond 90%.* This initiative will require introduction of Dirty MRF sorting of dry C&I waste the residual domestic waste. With growth in waste generation, additional efforts at resource recovery will be required to combat growth and maintain recovery outcomes above 90% in the long-term.

- *Option 5 – Export Waste from ACT.* At the request of TAMS one additional option was requested for modelling involving the assumption that waste would be exported from the ACT for disposal, eliminating entirely landfill disposal in the ACT. This option is unrelated to Options 1 to 4, and is presented as an alternative to the Base Case option.

The options are discussed below along with the diversion levels achieved.

5.5 How the Options Might be Achieved

Base Case – the Base Case assumes that all current and future efforts to divert waste from land-based disposal are put on hold and the progressive growth in waste volumes drives the recovery rate from just under 75% (in 2005) to around 56% by the end of the 20-year modelling period.

Option 1 – here it is assumed that ongoing efforts are directed at diversion of waste, but only to the extent needed to maintain overall recovery at the (2005) rate of 75%. This will see the tonnes recovered growing from the current (2005) rate of around 580,000 tonnes to over 950,000 tonnes by the end of the 20-year modelling period, but the rate of recovery remains fixed at 75% of the total amount of waste generated.

Option 2 – the move to 85% resource recovery would require comprehensive implementation of the initiatives described at Section 4, plus the introduction of the three-bin kerbside collection system for domestic waste. The initiatives included in this option are:

- additional kerbside recycling,
- additional home composting,
- intensified efforts to recover dry C&I recyclable materials,
- source separation of organic material at C&I waste generators,
- extra timber recovery from the C&D waste stream,

– recovery of other resources from the C&D waste stream, and
– introduction of a third organics bin for domestic collection in both the ACT and Queanbeyan.

The amount of material assumed to be collected in this service is taken to be 70% of the organic and food fraction available in the domestic waste stream. The domestic waste stream amounts to 52,600 tonnes per annum and comprise 50% organic and food matter. Therefore the initiative is estimated to yield some 18,000 tonnes/year of food waste per annum.

For the C&I sector, policy and financial settings would be required to encourage the source separation and processing of organic waste from the C&I sector, and some initiatives developed to encourage the waste collection contractors to provide additional services dedicated to source separated organics.

It is envisaged that the collection of source separated organic waste from the C&I sector will take a reasonable number of years to introduce and to achieve substantial quantities. For this option, a modest 7,000 tonnes per annum is estimated for inclusion, assuming that initial efforts might be targeted at highly obvious generating sources such as food processing and catering establishments.

Option 3 – a move to 90% would require further initiatives to recover the additional tonnes of resources per year needed. This could be affordably achieved through a further increase in domestic kerbside recycling, strong pursuit of source separation of organic waste in the business sector and Dirty MRF processing of the 20,500 tonnes/year of self-hauled domestic waste.

Option 4 – moving beyond 90% resource recovery would be difficult to accomplish in a cost-effective way at this point in time and with current technologies. It would require building a Dirty MRF processing facility for capture of the remaining domestic mixed waste, after separate collection of food waste from the ACT and Queanbeyan households, and possible targeting of the residual C&I waste stream through the Dirty MRF.

In addition to these measures, selected *other* wastes could be targeted using extended producer responsibility (EPR) policy. This could well form part of the continuous improvement steps in moving into the future and thus form part of the policy platform that the future strategy might adopt.

Finally, it could be feasible to add a form of AWT facility to process and stabilise the residual waste and render it inactive prior to placement in landfill. This technology is currently undertaken in many European centres, however, this is a costly initiative and, aside from GHG abatement, may be of limited value.

This option has been proposed as a possible final position for the strategy involving both further capital investment and continuous improvement as costs and technology permit, with the ultimate objective that no waste is disposed directly to landfill without first undergoing sorting or processing

Option 5 – Exporting Waste Outside the ACT

The No Waste Strategy and Targets involve an underlying assumption that the ACT Government continues with the current position where the ACT remains independent of other jurisdictions for the treatment and disposal of waste – i.e. all waste created in the ACT is managed within the ACT.

At the request of TAMS, Wright Corporate Strategy included consideration of the financial and economic sensibility of this position by assuming the export of waste for landfill disposal at the Woodlawn facility near Tarago in NSW, instead of landfilling the waste within the ACT, either at the existing Mugga Land facility or another facility established elsewhere in the ACT.

The underlying assumptions used for this option revolve around the Base Case Option, where there is a commitment to ongoing landfill as the main-stay of waste management in the ACT and no further actions are taken to maintain the current level of resource recovery. The option assumes that once the current landfill cell at Mugga Lane is filled, it would be capped and maintained, but no further landfill construction would be undertaken within the ACT.

Notwithstanding the outcome from financial and economic analyses, from a strategic perspective, exporting waste from the ACT for disposal at the Woodlawn facility would place the ACT Government in a difficult financial and tactical position, given that there would be no contestability in service provider, the ACT would become a price taker, and the ACT Government would most likely be put into a position where re-introducing landfill disposal within the ACT would face significant social, political and financial hurdles.

5.6 Delivering Diversion Through the Options

The above analysis is based on ACT waste data at 2006/07, and the steps are set out at Table 10 below along with the percentage gain in diversion from landfill that each initiative has capacity to deliver. Data relating to both the Base Case and Option 5 are not included since the data for Options 1 to 4 are relative to the Base Case and Option 5 is the same as the Base Case in terms of resource recovery.

Table 10 How the Options Deliver on Waste Diversion[1]

	OPTION 1[2]		OPTION 2[3]		OPTION 3		OPTION 4[3]	
	TONNES pa	%	TONNES pa	%	TONNES pa	%	TONNES pa	%
Domestic Waste (household) Sector:								
kerbside recycling	1,000		5,000		10,000		10,000	
green waste/home composting			7,000		7,000		7,000	
self-haul green waste drop-off	1,800							
food and garden organics processing			18,000		18,000		18,000	
residual (dry) waste processing							34,600	
self-haul drop-off waste process	1,800				20,500		20,500	
Commercial and Industrial (C&I) Sector:								
dry recyclable materials	1,800		30,000		30,000		30,000	
organic materials processing			7,000		25,000		25,000	
residual (dry) waste processing							37,800	
Construction and Demolition (C&D) Sector:								
timber waste recovery			3,000		3,000		3,000	
additional C&D recovery			6,000		6,000		6,000	
Total Further Diversion	**6,400**	**+1%**	**76,000**	**+10%**	**119,500**	**+15%**	**191,900**	**+25%**

Notes:
1. This table presents diversions achieved over and above the situation existing for the Base Case.
2. Attainment of Option 1 requires recovery of a further 6,400 tonnes over the Base Case in a no-growth situation.
3. The tonnages shown for Options 2 through 4 represent that amounts of waste materials diverted to waste sorting and processing systems and away from direct disposal to landfill. The net diversion will be lower taking in to account process rejects.
4. At Option 4, all waste is subject to some form of sorting or processing, giving a theoretical diversion from landfill of 100%; however when reject materials are taken into account the estimated net resource recovery is around 95%.

6. Financial and Objective Assessment of Options

6.1 Introduction

This Chapter presents an assessment of the six options proposed at Section 5 in terms of both financial impact and achievements in respect of a set of strategic objectives that might reasonably be expected of a waste strategy.

The strategic set of objectives has been developed by Wright Corporate Strategy to use as a basis for testing the options. These objectives are consistent with the idea of continuous improvement toward 'No Waste" as a general aspirational direction.

The objectives provide one input to the assessment of the options, which are then evaluated for their comparative financial impact. Non-financial, social and environmental impacts of the options are also assessed in this section using broad-brush techniques appropriate to the relatively small differences at the margin between the options.

Economic assessment of the options is presented at Section 7.

6.2 Objectives for Option Assessment

The Strategic and Functional Review of ACT Public Sector and Services found that the No Waste by 2010 target was not achievable within current budget allocations. This position was clarified in a document that formed part of the 2006 ACT (publicly available) budget papers.

"The Review found that the goals set out in the No Waste by 2010 strategy developed by the former Government are not achievable within current budget allocations. The Government recognises the achievements of the ACT community and remains committed to reducing landfill waste, but will review targets to an affordable and achievable level."

The emphasis in the statement is clearly on pursuing a resource recovery position that is fundamentally in harmony with ACT economic circumstances, but also in keeping with community views on resource recovery. This statement forms a basis for consideration of possible objectives and principles that might be central to a sustainable waste management strategy for the ACT. Sound objectives provide the basis for both deriving strategic policy options for consideration by Government, and a set of benchmarks against which to assess potential impacts of the various options.

The objectives developed by Wright Corporate Strategy are intended to capture the idea of social and economic gain from contributions to protect the environment. These objectives are not a part of any official policy or position of the ACT Government.

However, they have been framed in a way which avoids nominating either a timeframe or specifying an end-point numerical target for resource recovery or waste to landfill. This approach allows for variations to these strategic issues to be critically examined as the centrepiece of strategic options assessment.

Suggested Objectives for Assessment

(a) Protect the ACT environment from pollution.

(b) Reduce waste disposal consistent with affordable resource recovery initiatives that provide sound “conservation value for money”.

(c) Support community and business willingness to protect the environment by supporting opportunities for all to participate in minimising waste and contributing to resource recovery.

(d) Manage residential waste charges to reflect value and outcomes.

(e) Capture economic, environmental and social benefits of resource recovery initiatives for the Territory economy by encouraging development of resource recovery capacity and expertise.

(f) Ensure that products created from resource recovery initiatives are fit for sale in the market place and use for the most sustainable and beneficial purposes.

6.3 Basis of Financial Assessment

The purpose of the financial assessment is to clarify the relative merits of feasible options for strategic management of domestic and business waste in the ACT. The perspective taken is that of the ACT Government – as owner of the bulk of waste and resource recovery infrastructure in the ACT and the *Authority* responsible for protecting public health and environment as well as maintaining responsible stewardship of territory funds and assets.

Indicative Methods of Analysis

Impact Analysis. The *Planning Balance Sheet* approach weighs up both market and non-market impacts to provide an indication of scale and impact on specific interest groups, including the environment. This is a form of relative merit comparison to supplement (not replace) the main Benefit/Cost Analysis.

Multi Criteria Analysis. This technique also provides an indicative outcome, and is particularly relevant when used to assess the extent to which Program Objectives are met by the various options.

Although these techniques have been criticised as being pseudo-quantitative and subject to analyst-bias, they have a legitimate place in presenting a complete analysis and can be powerful in informing Government of the full implications of alternative courses of action.

Social Benefit/Cost Evaluation. A number of recent waste management assessments have attempted to use the social benefit/cost evaluation technique. Their aim has been to quantify environmental and other non-market impacts arising from waste management decisions so that the evaluation is fully comprehensive of all benefits and costs. The use of this procedure has been criticised where valuation estimates for intangible effects have been without foundation, or where the results have been seen by critics to be biased or exaggerated.

Not only are general valuations questionable, but specific valuations are highly dependent on site-specific conditions or technology brand-specific issues.

A feature of waste/resource recovery projects in general, is the high level of uncertainty about the extent to which intangible benefits can actually be achieved through the project life, and the valuation of the benefits. This uncertainty is compounded by the long project period over which waste management projects are usually considered.

Financial Modelling & Analysis. A project period of 20 years has been adopted for assessing the financial impacts on the ACT Government under the options. A Base Case, ceasing further resource recovery initiatives, has been established (described above) and the assessment addresses the commercial merit of options, assuming that the ACT Government does not invest capital in waste processing infrastructure, but continues to invest capital into landfill cells.

The strategic options have therefore been assessed on the basis of:

- evaluation of quantifiable costs and benefits;
- alignment with the tentative objectives set out above;
- discussion of potential non-quantifiable impacts.

Intangible impacts arising from each option are noted in a separate statement.

In considering the financial modelling and analysis it is critical to note that none of the models can be related directly to the “today recurrent budget”. The model for each option takes the “today recurrent budget” as the starting point and builds a 20-year forecast of the reasonably expected future costs (both capital and operations) and revenues that can be expected to arise as a result of the cumulative effects of:

- the amount of waste generated,
- the amount of resources recovered,
- the amount of waste disposed to landfill,
- the programs needed to achieve the forecast recovery levels, and
- the resourcing levels considered necessary at ACT NOWaste to manage the total waste and resource recovery activity.

On this basis, the model for each option assumes that forward capital budget provisions will be available as and when required (e.g. for landfill cells), and then accounted for in today-dollar terms via the net present value method. Inclusion of such forward estimates in discounted terms is not a feature of the "today recurrent budget".

Therefore, when drawing conclusions from the financial modelling, one is comparing alternative scenarios/options and not making comparisons with the "today recurrent budget".

6.4 Financial Evaluation

The financial analysis embraces estimates for quantifiable market costs and benefits arising from each option, including:

- Relevant collection contract costs, including bins and transport.
- Landfill costs – acquisition, approvals, capital, operating, closure and post-closure, and including mitigation requirements for treatment or landfilling activities, including noise, dust, odour.
- Waste treatment costs – contract gate fee costs for waste arising from sources that are the responsibility of the ACT Government, that are net of end-product revenues and fees for disposal of residuals.
- Gate fee revenue for materials from non-Government sources into the landfill.
- An estimate of the possible carbon credits that might be attributed to the options by virtue of GHG impacts achieved.

Results of the financial assessment indicate that in terms of total system financial outcomes, the difference between the Options 1, 2 and 3 is relatively small, while the challenge of moving beyond a 90% resource recovery rate, Option 4, represents a more significant increase in total system cost.

It is also apparent that the shift from Option 1 to either of Options 2 or 3 involves approximately the same total system cost increase. The financial assessment finds Option 5 the least attractive of all of the options, when viewed from the perspective of the ACT Government

It is also worthy of note here, that if the social and environmental benefits that are discussed later in this chapter are taken into consideration, then the gap between the Base Case and all other options will narrow considerable.

The results are summarised at Table 11 below. Discussion on the methodology for the financial assessment is at Attachment 1. In Table 11, it should be noted that the revenues reported are from tip fees received from waste generators sending waste to landfill. As progress is made in achieving higher levels of resource recovery, so waste to landfill falls and tip fees fall accordingly resulting in higher overall costs for waste management in the ACT.

Table 11 Summary of Financial Analysis

Option	NPV Values ($millions)							
	Costs							
	Capital	Operations	Total Costs	Revenues	GHG Credits	Net Valuation	Net Benefit Over Base Case	Ranking
Base Case	$ 97	$ 239	$ 336	$ 255	-	-$ 82	-	1
Option 1	$ 83	$ 250	$ 333	$ 232	-	-$ 101	-$ 20	2
Option 2	$ 60	$ 297	$ 358	$ 189	$ 52	-$ 117	-$ 35	3
Option 3	$ 42	$ 295	$ 337	$ 153	$ 59	-$ 126	-$ 44	4
Option 4	$ 38	$ 308	$ 346	$ 123	$ 59	-$ 163	-$ 82	5
Option 5	$ 19	$ 274	$ 292	$ 98	-	-$ 194	-$ 113	6

In this table, the total costs for each option, broadly represents the today value of the 20-year costs and revenues to manage the waste services and resource recovery activities for the Territory.

The data shows that when waste is diverted from landfill disposal to beneficial resource recovery, the following impacts appear in the financial outcome:

- the capital investment required by the ACT Government for new landfill capacity is reduced;
- there is marginal increase in the cost of operations and fees paid for waste processing,
- the revenue generated through gate fees from non-Government waste decline, and
- the carbon credits that might be imputed through beneficial processing go some way towards off-setting the loss in landfill gate fees.

6.5 Impact Assessment

A number of impacts would arise as a result of implementing each of the options. These benefits and issues are briefly analysed below in relation to the suggested objectives set out as an additional basis for assessment beyond financial considerations.

Objective (a) Protect the ACT environment from pollution impacts.

Landfill design criteria and operating practices across Australia have become progressively more stringent over the last ten years, and this trend can be expected to continue. Regulatory regimes are specifically geared to preventing or at least minimizing pollution of local environments. NSW and Victoria may be slightly ahead of other jurisdictions in standards for leachate management, wind-blown litter, significant odour nuisance, etc, however other States and Territories, including ACT, will likely adopt the higher standards over the next five years.

This will add further to the costs of preventing pollution, forcing up the already high overall landfill management costs. The cost of this level of pollution protection will vary in line with differences in overall amounts of waste despatched to landfill between the options.

Total waste to landfill for each option over the 20-year project period is set out at Table 12, below:

Table 12 Waste to Landfill over 20 year Project Period ('000 tonnes)

	BASE CASE	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
Total Waste to Landfill	6,248,147	5,067,938	3,432,767	2,687,760	2,058,627	6,248,147

Objective (b) Reduce waste disposal consistent with affordable resource recovery initiatives that provide sound "conservation value for money".

Options 2, 3 and 4 would result in substantially increased resource recovery and further step-by-step reductions in waste to landfill (as shown at Table 12above). The merit of the required initiatives is associated with three types of direct benefits: reduced landfill capital and operating costs; market value of recovered resources; and environmental and social benefits – particularly arising from avoidance of future landfill gas emissions. Each of these impacts is described below.

Reduced Landfill Costs

Waste disposal costs are a direct cost to the community and business. The main cost issues include:

(a) landfill capital costs (including land acquisition, landfill cell development, and closure, including site decontamination);

(b) landfill operating costs (covering fixed and variable costs);

(c) pollution management costs during the landfill life and post-closure;

(d) alienation of land from other productive uses for many decades.

Variations in landfill costs for each option are estimated, and the basis for the analysis and details for each option are set out on the analytical spreadsheets accompanying this review.

The estimated capital costs for landfill activities have been derived from earlier work commissioned by ACT NOWaste, from data available to WCS and from data prepared by ACT NOWaste for the construction of the current landfill cell at Mugga Lane. The estimated operating costs for landfill activities have been derived via a similar approach.

Preparing a current market-based assessment of landfill costs was not a part of this assignment; however, the estimates used are considered to be sufficiently accurate for the purposes of comparing alternative options, as is required for this review. Notwithstanding the quality of these estimates, it is recommended that serious consideration be given to the preparation of current market-based assessments of landfill ownership and operation costs within the ACT under the regulatory regimes that are anticipated within the next couple of years.

The Options also vary in their requirement for land to be set aside for landfill construction, operation and post-closure maintenance. Continuation of business as usual, which is essentially represented in the Base Case option creates for the ACT Government and community a significant legacy in respect of exhausted landfills, alienated land, environmental risk, and long-term management of these sites.

For the financial modelling on this assignment it was assumed that once the current landfill cell at Mugga Lane was exhausted a new landfill site would be used at some, still to be identified, relatively near site. Assumptions relating to the site included:

- the site would be located such that existing transfer facilities at Mitchell and Mugga Lane would be sufficient to service the community's needs for dispatch of waste to the new site without the need for additional transfer facilities or for any significant increase in transport costs, and

– the site would be of sufficient area to cater for five cells each of 2 million cubic metres capacity – an area equivalent to 60 ha of landfill cells – plus a similar area of surrounding un-disturbed land for buffering.

The broad position, covering each of the Options, is illustrated at Table 13 below.

Table 13 Landfill Legacy Implicit in Options

	BASE CASE	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
Area of alienated land in the ACT	48 ha	36 ha	24 ha	12 ha	12 ha	12 ha

Value of Recovered Resources

Recovered resources have value as transformed product available for direct use such as mulch from green waste or input to new product manufacture, such as shredded PET as polymer input for new PET bottles or paper pulp as input for newsprint manufacture. Long run resource market value should reflect the full resource value inclusive of manufacture of primary resources.

ACT NOWaste resource recovery contracts presently provide for contractors to retain revenue gained from sale of any recycled material. Thus, sales revenue from recovered resources does not flow back to the Government, but rather is absorbed within the service contract reflecting a net price. This includes kerbside recyclables, green waste, and C&I/C&D recovered material that is the responsibility of the ACT Government.

As a result of this contract pricing arrangement, the ACT Government pays a lesser cost for the sorting and resource recovery services, reflecting the on-selling benefit that the contractor receives.

It is usual for AWT contracts to carry similar provisions, and this has been allowed for accordingly.

In addition to the direct financial benefits associated with resource recovery gains, there will be indirect benefits in additional employment associated with the extra tasks in resource recovery plus reduced demand for virgin materials with the associated savings in energy, water and GHG impacts.

The value of resources recovered is accounted for in the section dealing with economic assessment of the options.

Greenhouse Gas Abatement

Global pollution associated with greenhouse gas emissions resulting from waste disposal to landfill are not yet formally regulated for environment protection. However, the former Australian Greenhouse Office (AGO) has formally recognised a quantum of emissions attributable to waste disposed to landfill, and there are signs that greenhouse gas emissions from waste disposal activities will eventually be accounted for in the proposed national emissions trading system.

Food and other organic wastes (food, paper, wood, garden waste etc) decompose in landfill conditions to form methane, carbon dioxide and other greenhouse gases which are ultimately released to atmosphere. It follows that recovery and processing of wastes that contain degradable organic carbon can make an important contribution to greenhouse gas abatement. Estimates of the extent of abatement directly attributable the project options are described in the following section.

Reduced Greenhouse Gases from AWT initiatives

Establishment of AWT facilities would reduce the volume of greenhouse gas generation that would otherwise result from continued landfilling of organic wastes that could be processed. The purpose of this analysis is to estimate the potential amount of greenhouse gas saving available through diversion of organic waste from landfill to AWT.

Consistent with the No Waste Strategy, it is assumed that a small AWT facility would be developed to process source streamed C&I food waste as part of Option 2. An extension to the organics waste AWT, to process source separated domestic food waste, is proposed for Options 3 and 4. And dirty MRF processing of mixed waste is proposed for Option 4, followed by some stabilisation of residuals prior to landfill disposal.

Thus, the ACT No Waste Strategy would result in the following diversions to AWT/composting type processing operations that would have beneficial abatement outcomes in terms of greenhouse gases:

For Option 1: No change to current compost level

For Option 2:

- 18,000 tonnes/year of ACT and Queanbeyan kerbside collected household separated food waste
- 7,000 tonnes/year of C&I food waste
- 7,000 tonnes/year of household composting

For Option 3:

- all of the above for Option 2, plus
- a further 18,000 tonnes/year of C&I food waste

For Option 4:

- all of the above for Option 3, plus
- upwards of a further 34,600 tonnes/year of ACT and Queanbeyan mixed residual waste with food waste from only 30% of residences.

For Option 5: No change to current compost level

The AGO published estimates of emission factors for various waste material types[1]. For food waste, the default landfill emission factor is 0.9 tonnes $CO_{2\text{-}e}$ (equiv) / tonne of waste. For mixed domestic waste, the default landfill emission factor is 1.14 tonnes $CO_{2\text{-}e}$ (equiv) / tonne of waste.

Where facilities are equipped with gas capture and flaring or gas processing for fuel it is appropriate to reduce the emission factor to reflect gas capture performance.

The greenhouse gas abatement capabilities of various AWT classes and types differ markedly. As no consideration has yet been given by ACT NOWaste to the type of AWT that may be procured if Options 2, 3 or 4 were adopted, an Aerobic Biological system of composting has been assumed. These devices are generally capable of eliminating GHG emissions during processing provided that the compost maturation process is managed so as to ensure continuity of an environment for microbial decomposition and avoid pockets where anaerobic decomposition can proceed, with consequent GHG emission.

Where process residuals are landfilled without stabilisation (all Options except Option 4) a measure of GHG production can be expected. The stabilisation process essentially relates to an aerobic processing of mixed waste, and it has been assumed that the CO_2 production rate is half the rate for mixed waste containing food waste.

Calculation of Direct GHG Emission Abatement

Option 1: No emission reduction.

[1] Technical Guidelines for the Estimation of Greenhouse Emissions and Energy at Facility Level for waste sectors, published by the Department of Climate Change in 2007.

Option 2:

- Landfill emission level avoided (food waste): 32,000 tonnes x 0.9 tonnes CO_2 (equiv) = 28,800 tonnes CO_2 (equiv).
- AWT emission level (estimated contamination in 25,000 tonnes of collected food waste @ 2%): 500 tonnes x 0.9 tonnes CO_2 (equiv) = 450 tonnes CO_2 (equiv).
- ***Resulting GHG emission saving: 28,800 – 450 = 28,350 tonnes CO_2 (equiv)/year.***

Option 3:

- Landfill emission level avoided (food waste): 50,000 tonnes x 0.9 tonnes CO_2 (equiv) = 45,000 tonnes CO_2 (equiv).
- AWT emission level (estimated contamination in 43,000 tonnes of collected food waste) @ 2%): 860 tonnes x 0.9 tonnes CO_2 (equiv) = 774 tonnes CO_2 (equiv).
- ***Resulting GHG emission saving: 45,000 – 774 = 44,226 tonnes CO_2 (equiv)/year.***

Options 4:

- Landfill emission level avoided (food waste): 50,000 tonnes x 0.9 tonnes CO_2 (equiv) = 45,000 tonnes CO_2 (equiv).
- Landfill emission level avoided (mixed residual waste): 34,600 tonnes x 30% non-participants x 50% putrescible waste content x 0.9 tonnes CO_2 (equiv) = 4,671 tonnes CO_2 (equiv).
- AWT emission level (estimated contamination in 43,000 tonnes collected food waste) @ 2%): 860 tonnes x 0.9 tonnes CO_2 (equiv) = 774 tonnes CO_2 (equiv).
- ***Resulting GHG emission saving: 49,671 – 774 = 48,897 tonnes CO_2 (equiv)/year.***

Option 5: No emission reduction.

Reduced Greenhouse Gases from Recycling

Increased recycling of biodegradable materials also contributes directly to reducing GHG emissions. The ACT No Waste Strategy nominates C&I dry waste (mostly paper/cardboard), domestic green waste, and C&D timber waste for increased recovery initiatives. These are the materials identified in the Strategy which would be significant GHG contributors with continued landfilling.

The WCS Review of the Strategy confirmed the following resource recovery levels resulting in diversions from landfill for Options 2, 3 and 4:

- 30,000 tonnes/year of C&I waste – mostly paper/cardboard;
- 3,000 tonnes/year of C&D timber waste.

The AGO estimates of emission factor for paper/cardboard is 2.5 tonnes CO_2 (equiv) / tonne of waste. For timber waste the factor is 3.2 tonnes CO_2 (equiv) / tonne of waste. Ready markets are available for paper/cardboard. It is considered that markets could progressively be developed for timber.

Calculation

- Landfill emission level (paper/cardboard): 30,000 tonnes x 2.5 tonnes CO_2 (equiv) = 75,000 tonnes CO_2 (equiv).
- Landfill emission level (timber): 3,000 tonnes x 3.2 tonnes CO_2 (equiv) = 9,600 tonnes CO_2 (equiv).

- ***GHG emission saving: 75,000 + 9,600 = 84,600 tonnes CO_2 (equiv)/year.***

This GHG saving relates to Options 2, 3 and 4.

Social Cost of Greenhouse Gas Emissions

There has been much debate about the social cost of greenhouse gas emissions but, in the absence of a carbon price in Australia, no clear conclusion. The Stern review suggested a social cost of carbon of some US$85/t$CO_2$ in conditions of "unmitigated climate change" but, under stabilised conditions, this was reduced to US$25-30/tonne CO_2.

In the absence of a national trading scheme the NSW Government established the NSW Greenhouse Abatement Certificate Scheme. Recent value was around $13/tonne CO_2. However, the ACT Government reportedly uses values in the range $21 to $39/tonne CO_2. On this basis the composting schemes could be valued at up to $1.9 million/year and the main C&I dry recycling initiatives might be valued at close to $3.3 million/year – with both of these values estimated on the basis of tonnes destined for composting at 2008/09.

It is however noteworthy that neither NSW nor any other Australian State or Territory has enacted legislation or taken regulatory action to prevent discharge of landfill gas to the environment. Given the absence of a carbon signal and the absence of Government action to require GHG mitigation, it is considered appropriate to consider the issue in analysis of impacts, but less appropriate to embed imputed carbon cost estimates into financial evaluation in a non-transparent manner.

On this basis, estimates for the imputed GHG abatement credits are computed for each option and stated separately from other (cash) revenue sources.

Objective (c) Support community and business willingness to protect the environment by supporting opportunities for all to participate in minimising waste and contributing to resource recovery.

Options 2, 3 and 4 increase the opportunities for industry and households to do more recycling. All the proposed initiatives provide scope for ACT NOWaste programs that encourage streaming of waste types at the point of discard. The opportunity level is assumed to be proportional to the level of resource recovery - vis, 74% for Base Case beyond 90% for Option 4.

At the household level, there is clear scope for increased separation and recovery of recyclables for kerbside collection. Resource recovery from the C&I sector needs a boost – and the landfill gate price is sufficiently high to provide a reasonable incentive to this sector to source-separate recoverable materials.

This objective could be brought to life by a set of complimentary policy initiatives: education/communication initiatives, including getting ACT waste service contractors working with their customers on better resource recovery; financial incentives such as reduced gate price for certain source separated materials; and regulatory initiatives to ban landfilling of certain materials prior to processing.

Objective (d) Manage residential waste charges to reflect value and outcomes.

The options under consideration would require varying levels of funding for ACT NOWaste to enable development and maintenance of programs to drive the various initiatives for the management of domestic waste. However, the likely significant additional charges for management of domestic waste generally only arise when the waste is processed in lieu of being disposed to landfill, for example when source separated food waste is processed in a compost facility or mixed residual waste in processed through a dirty MRF and residuals stabilised.

To some degree the cost increases associated with processing in lieu of landfill are negated as the landfill price increases and approaches the price of the processing option. However, ratepayers would be required to pay for additional services introduced (third organics bin) and for improved outcomes.

Objective (e) Capture economic benefits of resource recovery initiatives for the Territory economy by building resource recovery capacity and expertise.

Job Creation

In 2006, a skills audit was conducted for the waste management industry in Australia, providing specific industry data that allows for order of magnitude employment levels to be forecast for various activities in the waste management industry. That data has been used to estimate the likely growth in demand for employees in the ACT waste sector as a result of implementing each of the options.

By virtue of the growth in waste generated in the ACT, there will be a natural growth in the demand for people engaged in the waste management and resource recovery activities. Table 14 below shows both the expected job growth demand by 2026/27 and the growth as an approximate percent of current levels of employment in the industry in the ACT.

Table 14 Employment Demand Over the Base Case at 2026/727

Waste Management Activity	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
Landfill Operations	-10	-14	17	-19	-22
MRF Sorting	15	41	45	45	0
Garden Waste Processing	47	52	52	52	0
Waste Processing – (Dirty MRF & AWT)	23	31	53	129	0
C&D Waste Processing	25	30	30	30	0
Transfer & Export	0	0	0	0	27
TOTAL NET CHANGE	**100**	**140**	**163**	**237**	**5**

Private Sector Business Growth

Associated with the increase in resource recovery and job creation, will be a growth in the magnitude of the private sector businesses that will support the ACT Government in resource recovery activities.

In a similar manner to the forecast for employment growth, forward estimates have been made for private sector business growth for each of the options and compared with the Base Case option. This data is presented at Table 15 in terms of the annual increase in the value of business activities by 2026/27, the end of the 20-year project modelling period.

It should be noted that there is no change over the Base Case for Option 5.

Table 15 Private Sector Business Growth Over the Base Case ($ million p.a.)

WASTE MANAGEMENT ACTIVITY	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
MRF Sorting	$1.52	$4.08	$4.48	$4.48	nil
Garden Waste Processing	$2.34	$2.62	$2.62	$2.62	nil
Waste Processing	$1.13	$3.00	$5.80	$13.28	nil
C&D Waste Processing	$2.28	$2.74	$2.74	$2.74	nil
TOTAL NET CHANGE	**$7.27**	**$12.45**	**$15.64**	**$23.13**	nil

It should be noted that these estimates reflect on only the processing operations to extract resources from the various streams presented for processing. Since the end markets and next steps of value-add are unknown, it is not possible to estimate the contribution that these subsequent activities to the ACT economy.

Objective (f) Ensure that products created from resource recovery initiatives are fit for sale in the market place and use for beneficial purposes.

The ACT resource recovery approach to date has been successful in creating products that have found willing buyers in competitive markets. Continuation of high quality product output is a logical objective given the expenditure of public funds. However, the initiatives available to move from the current level of resource recovery to 85% recovery and beyond will necessarily involve more challenging resource recovery and waste processing demands.

Key target waste streams, due to their scale and presence of food waste and other compostable materials, are:

- Domestic waste to landfill (nearly 60,000 tonnes/year) which presents mostly as mixed residual waste, with a high organic content (mostly food and paper waste).
- C&I waste to landfill (nearly 90,000 tonnes/year) which mostly presents in mixed waste loads and is estimated to include more than 60,000 tonnes/year of compostable food, paper/cardboard, and garden waste.

Option 2 includes the initiative of capturing some 18,000 tonnes/year of source separated food waste from domestic and C&I sources for processing to produce high quality compost product. Provided streamed food waste can be obtained, this waste stream should result in quality output products.

Option 4 would require sorting and stabilising domestic putrescible waste. The residual mixed waste feedstock is unlikely to yield satisfactory compost product and it is proposed that processing would be limited to recovering recyclable metals, plastics and limited paper, followed by landfill disposal of the stabilised residual.

6.6 The ACT NOWaste Recurrent Budget

In the foregoing analysis, the recurrent budget of ACT NOWaste was taken to be represented by the net cost of waste management and resource recovery activities, exclusive of GHG carbon credits or revenues for commercial and other non-domestic waste. This is considered to reasonably represent the recurrent budget demand for ACT NOWaste.

However, the modelling for this study makes allowances for full future (20-year) demands for capital and operating costs associated with managing the waste of the ACT – features that are not currently included in the recurrent budget of ACT NOWaste.

The current form of the recurrent budget for ACT NOWaste is a relatively short-term snapshot of operating and short-term capital demands to manage waste and resource recovery for, perhaps two to three years ahead. The current form of recurrent budget makes no allowance for significant future capital requirements.

In addition, the current recurrent budget of ACT NOWaste makes little provision for the inexorable growth in population, growth in waste generation and inflationary impacts on costs.

The combined effect of these issues is that the current recurrent budget of ACT NOWaste cannot be maintained, as sought by the findings of the Government Review, and indeed will need to be increased appreciably just to maintain waste management standards, public health and sound environmental outcomes.

It is therefore critical for future planning that medium- to long-term forecasts be prepared for the capital demands of efficiently running the waste management system of the ACT so that a realistic picture of the forward recurrent budget of ACT NOWaste can be established. This is especially critical given the large and non-uniform annual capital outlays that will be required for landfill cell construction and closure over the years ahead.

7. Economic Assessment

7.1 Methodology

This section provides a triple bottom line (TBL) assessment of a range of policy options that might be adopted under the No Waste by 2010 Strategy. The assessment draws on the results of a financial review and assessment of strategy options presented in section 5.

A conventional cost-benefit assessment of economic impacts is firstly provided which incorporates monetary valuations of key impacts, including environmental impacts. This is followed by an assessment of environmental impacts in physical terms, and an assessment of social impacts in terms of financial implications to various stakeholder groups including the ACT Government.

An overview of the methodology employed to undertake the TBL assessment is provided in this section

7.1.1 Assessment Approach - the TBL assessment provides a conventional cost-benefit assessment of economic impacts drawing on the results of the financial review and assessment of strategy options. The conventional cost-benefit assessment incorporates the economic costs and savings identified in the financial analysis and includes environmental impacts where monetary values can be assigned.

An inventory of environmental impacts is also provided. These impacts are associated with the options and account for changes in resource use, air and water pollution and greenhouse gas emissions. Social impacts are also outlined, including financial impacts on the ACT community and households, employment opportunities, as well as the distribution of environmental benefits within and outside the ACT.

The assessment identifies the incremental economic, environmental and social impacts of a range of options compared to the base case situation. The Base Case and five options considered are those reported in the financial analysis.

Under the Base Case it is assumed that the ACT Government stops progressing waste minimisation and relies entirely on landfill disposal. However in the face of increased levels of waste generation by the ACT community, this results in a steady reduction in the proportion of resource recovery (from 75% currently to around 56% over twenty years) and increased volumes of waste to landfill.

The key features of the alternative options, relative to the Base Case are:

- Option 1 – Maintain resource recovery at approximately 75%.
- Option 2 – Increase resource recovery forward to approximately 85%

- Option 3 – Increase resource recovery forward to approximately 90%
- Option 4 – Increase resource recovery forward beyond 90%
- Option 5 – Export waste from ACT and stop progressing waste minimisation (as per the Base Case).

Standard economic assessment techniques are applied to identify economic impacts. Market impacts have been identified primarily from the financial analysis. Non-market economic impacts, such as damages arising from pollutant emissions, have been developed by applying monetary valuations to identified changes in environmental loadings.

The incremental economic benefits and costs of the options compared to the base case are estimated over a 20-year period (at a 5% discount rate) consistent with the financial analysis. Costs are defined in terms of marginal opportunity costs and include capital and operating expenditures and other economic costs identified in the financial analysis as well as environmental impacts. Benefits are defined in terms of marginal willingness to pay and include value of outputs, avoided costs, and environmental benefits.

The financial analysis identifies the costs to the ACT government of the landfilling and recycling of materials under each option. These include the:

- collection contract costs – including bins and transport for collection of waste
- landfill costs – both capital and operating costs
- waste sorting and treatment costs – for domestic sources that are the responsibility of the ACT government.

Additional economic costs that are not borne by the ACT Government have also been included in the economic analysis. These include any extra collection, sorting and treatment costs for wastes from sources that are not the responsibility of the ACT government for C&I and C&D wastes. The analysis also includes the additional costs for transport of all recyclates from MRFs to reprocessing facilities or reuse locations.

The assumptions relating to the additional waste collection, sorting, treatment and recyclate transport costs included in the economic analysis are presented at Attachment 4.

Estimation of environmental benefits involves both identifying physical environmental changes (pollution loads) under different options and developing monetary values for those changes in the ACT. The monetary values for pollution loads are based on benefit transfer techniques adjusted to reflect the ACT context.

To identify physical environmental changes, relevant life-cycle impact inventories have been drawn on. This data has been supplemented with ACT specific data wherever possible, such as in relation to transport distances and the operational performance of facilities such as landfills.

Increased recovery and recycling under the options will lead to a range of environmental impacts across relevant supply chains. 'Upstream' changes to resource extraction, transport, processing and consumption will arise as the recovered materials are recycled. This will lead to changes in overall resource consumption as well as changes in associated externalities such as the generation of greenhouse gases and other air and water pollutants.

Notably, the assumption that recyclate directly substitutes production based on the use of virgin materials needs to be qualified. Most resource markets are highly competitive and Australian producers are price takers. Therefore new resources provided to the market through recycling rarely impacts resource prices but rather allow an expansion in consumption – leading to a less than proportional reduction in the use of virgin materials and realisation of associated benefits.

Accordingly, estimated upstream benefits, in the form of resource conservation from less extraction of virgin material and from reductions in pollution impacts associated with the extraction and processing of those virgin materials, represent a maximum.

There will also be 'downstream' changes in the handling of recyclates, notably a reduction in the quantity of waste being disposed to landfills or changes in the amount of wastes disposed to the environment through illegal dumping. This will generate benefits through reduced generation of pollutants at landfills.

Estimates of emissions avoided through recycling of key recyclate materials have been drawn primarily from the Life Cycle Analysis Australian Data Inventory Project April 1999 by RMIT and the Cooperative Research Centre for Waste Management and Pollution Control. The emissions estimates cover those associated with extraction of raw materials, primary processing and manufacturing (up to the factory gate). For recyclate materials not covered by this database, the latest available data from the National Pollutant Inventory has been used for relevant industry categories.

Estimates of emissions from recycling/reprocessing of materials have been be sourced from the Life Cycle Assessment for Paper and Packaging Waste Management Scenarios in Victoria January 2001 by RMIT and the Cooperative Research Centre for Waste Management and Pollution Control.

Cost and time prevent the development of environmental values through primary valuation techniques. As is common in most environmental policy assessments, benefit transfer techniques which use values from other sources have been relied upon.

Social impacts identified include financial impacts on the ACT community and households, employment opportunities, as well as the distribution of environmental benefits within and outside the ACT.

7.1.2 Inventory of Environmental Impacts - the first step in assessing the environmental impacts of increased recoveries of recyclates is developing an inventory of impacts. To this end, impacts across product supply chains have been identifies, capturing upstream changes associated with resource extraction, processing and consumption, downstream changes in how materials are disposed, such as to landfills or into littering and illegal dumping streams, and impacts associated with transport across all stages of identified supply chains. At Attachment 4 examples of impacts included in the life cycle inventory are provided.

Materials included in Life Cycle Analysis (LCA)

The materials associated with increased recyclate recoveries may serve to displace the use of virgin materials in production processes, leading to reductions in raw materials use and changes in emissions and other resources used in manufacturing processes and related transport activities.

The primary pathways assumed for recycled material from the ACT are:

- *Paper, newsprint and liquid paper board (LPB)* - paper is recovered by private collectors from industry and from household kerbside collections. The recovered material is sorted, graded and sent to paper mills in NSW. Recycled paper is assumed to be used in production of cardboard, displacing virgin materials that would otherwise have been used to create this product.
- *Glass* - glass is collected from kerbside collection systems and sorted by colour. Sorted coloured glass is sent to NSW and glass fines to Victoria. Both are used to replace some raw materials in glass production.
- *Non-ferrous metals* - aluminum scrap is sourced from building material waste, automotive manufacturing other manufacturing activities and aluminum cans are recovered through kerbside collection systems. Aluminum cans and scrap is sent to NSW for beverage can production or for production of aluminum products.
- *Steel* - steel is assumed to be recovered from commercial and industrial sources, construction and demolition wastes, and kerbside collection (steel cans). Scrap steel and steel cans are reprocessed in NSW or Victoria and are assumed to replace pig iron production in the blast furnace.

- *HDPE* - recovered HDPE is sent to NSW. The recovered material displaces HDPE products made from virgin materials.
- *PET* - recovered plastics are sent to NSW. The recovered materials are reprocessed into other containers displacing PET products made from virgin materials.
- *Mixed plastics* – mixed plastics are assumed to be reprocessed into a long life replacement for hardwood milled timber.
- *Garden organics* - green waste is recovered through self-haul drop-off at transfer stations and other facilities. This waste is assumed to go directly to mulching or composting facilities. Green waste mulch and compost is assumed to displace soil conditioning products used by horticultural and viticultural enterprises, as mulch on public parks and council gardens and as fertiliser/mulch used on household gardens.
- *Food organics* - food organics are assumed to be mainly organic wastes and soiled paper with some meat and meat by-product waste. These materials are assumed to be recovered and processed for compost.
- *Concrete* - recovered concrete is processed by crushing the concrete, removing steel reinforcement, screening and converting into useable products. The material is assumed to be sold within the ACT and immediate surrounding region for aggregate for road making and buildings to replace quarry based products.
- *Bricks, soil and rubble* - bricks soil and rubble recovered from building and demolition sites are assumed to be crushed and screened to make soil and aggregate products in the ACT.
- *Asphalt* - recovered asphalt is assumed to reprocessed within the ACT for use in cold batch road base applications or as a substitute for quarry products in aggregate mixes.
- *Timber* - timber comes from construction and demolition sites, off cuts and sawdust from wood products manufacturing plant and discarded pallets, fences and furniture. Recovered material is assumed to be chipped and mixed in composting facilities in the ACT or used as mulches in landscaping supplies.

The assumed production displaced by recyclates is summarised at Table 16

Table 16 Displaced Virgin Material From Recyclate Recovery

RECYCLATE	DISPLACES
Paper	Virgin materials used in production of pulp
Glass containers	Some raw materials in glass production
Aluminum cans	Production of aluminum ingots
Steel tin plate containers	Pig Iron production in blast furnace
HDPE containers	HDPE production
PET containers	Production of bottle grade PET overseas
Garden organics	Soil conditioner/mulch
Food organics	Compost/mulch
Concrete/bricks/asphalt	Quarry aggregate
Timber	Fertiliser/mulch

Composition of Recyclables in ACT

The financial analysis provides estimates of additional resource recovery for various recyclables in different waste streams. In order to assess the costs and benefits of the increased recycling it was necessary to develop an indicative breakdown of the composition of "kerbside dry recyclables", "commercial and industrial dry recyclables".

At Tables 17 and 18 the compositions assumed for the estimation of market values and environmental impacts of the dry recyclables from kerbside and C&I sources respectively are presented. The recyclables in the construction and demolition sector are separated into timber and other in the financial analysis. Table 19 shows the assumed makeup of the "other construction and demolition recoverables".

Table 17 Composition of Kerbside Dry Recyclables

MATERIAL	PERCENTAGE
Mixed paper – Paper, board, LPB packaging, newsprint	59.7
Glass containers	23.8
PET bottles	4.8
HDPE packaging	2.0
Other plastic packaging & film	2.6
Steel cans/packaging & other ferrous scrap	1.8
Aluminum cans	0.7
Other	5.2

Source: APC Environmental Management, Domestic Waste Audit for Thiess Services and ACT NoWaste, November 2007

Table 18 Composition of C&I Dry Recyclables

MATERIAL	PERCENTAGE
Mixed paper – Paper, board, LPB packaging, newsprint	74.0
Glass containers & scrap glass	7.9
Aluminum cans and scrap aluminum	2.4
Steel cans & scrap steel	0.5
Other metals	14.3
PET bottles	0.3
HDPE packaging	0.3
Other plastic packaging & film	0.3

Source: Commercial-Municipal data split provided by Wright Strategy

Table 19 Composition of C&D Recyclables (other than timbers)

MATERIAL	PERCENTAGE
Asphalt	15%
Concrete	77%
Steel	8%

Source: In the absence of ACT data, an approximate composition of the three key ACT materials has been developed from Hyder 2006 Recycling Activity in South Australia 2005/06.

Emissions (greenhouse gases, air and water pollutants)

Emission production was assessed throughout the waste management lifecycle both within and outside ACT. Emissions accounted for include:

- emissions avoided by recycling recovered materials rather than producing products from virgin materials.
- emissions produced through the collection, transportation and reprocessing of recyclates.
- emissions avoided through reduced collection, transportation and disposal of recyclates to landfill.

The LCA captures round 38 materials used in production, 140 emissions to air, 100 emissions to water, 30 materials to landfill and 10 non-material types; although only those where significant changes are identified are reported here. Emissions included in the life-cycle inventory include for example:

- *air emissions* – benzene, carbon dioxide, carbon monoxide, hydrogen sulphide, lead, mercury, methane, nitrous oxide, oxides of nitrogen, particulates, sulfur dioxide, volatile organic compounds.
- *water emissions* – arsenic, benzene, biological oxygen demand, cadmium, chromium, copper, lead, nitrogen, oils and greases, phenol, phosphorus, polycyclic aromatic hydrocarbons, suspended solids, zinc.

Estimates of emissions avoided through recycling of key materials cover those associated with extraction of raw materials, primary processing and manufacturing and transport of materials (up to the factory gate) for the products or virgin materials displaced. The location of emissions within or outside the ACT is identified.

Estimates of emissions from recycling/reprocessing of key materials drawn from LCA databases have been adjusted for transport impacts applicable to the ACT context.

Average vehicle emissions per tonne kilometre across a range of vehicle types have been developed. The emission rates are from the Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks 2005 published by the Australian Greenhouse Office and the BTRE report Greenhouse Gas Emissions from Transport: Australian Trends to 2020 published in 2002 (Report No. 107).

Estimates of rail emissions per tonne kilometre of freight rail have been developed from BTRE Report No. 107.

The greenhouse emissions from landfilling of wastes have been derived using the Technical Guidelines for the Estimation of Greenhouse Emissions and Energy at Facility Level for waste sectors, published by the Department of Climate Change in 2007. The estimates take into account the current extent of methane capture at both the Mugga Lane landfill in the ACT and at Woodlawn. Both landfill gas collection systems are assumed to achieve 75% efficiency.

Other emissions from landfilling of wastes have been estimated using the National Pollutant Inventory Emission Estimation Technique Manual for Municipal Solid Waste Landfills published by the Department of Environment and Heritage 2005. It is assumed that the Mugga Lane and Woodlawn landfills do not have any emissions to water, given that their leachate collection systems collect all leachate generated. Landfill leachate liners are guaranteed for around 15 years. It is recognised that post closure management will be required for longer than the 20-year period of this assessment, but this longer term mitigation liability is not quantified in the analysis.

Resource Savings

Estimates of savings in raw materials, fuels, water and energy use arising from the use of recyclates in favour of virgin materials was derived from the LCA studies described above. Again, only those where significant changes are identified are presented in our results.

7.1.3 Monetary Valuation of Environmental Impacts - an overview of monetary values used in the economic analysis is presented. The notion of opportunity cost underpins economic valuation.

Opportunity cost is the cost of what has to be given up to gain some good or service. In competitive markets, pricing at marginal cost implies that costs and benefits are equated with their opportunity costs. In the case of benefits, the price that the marginal consumer is willing to pay represents what he or she is willing to forgo through not purchasing something else. In the case of costs or inputs, the price implies the amount that alternative producers would be willing to pay for the particular input.

To provide a comprehensive benefit cost analysis, the health and environmental impacts of alternative policy settings need to be accounted for. As market prices for these impacts cannot be readily observed, shadow prices need to be identified which reflect the marginal social opportunity cost of the impacts.

A range of valuation techniques have been developed to estimate these shadow prices, from techniques that variously seek to directly measure damage costs (or the community willingness to pay to avoid impacts) or other surrogate measures such as preventative expenditures. The range of techniques can be grouped under three broad approaches – market-based, revealed preferences and stated preferences. Each approach has different levels of theoretical sophistication, data requirements, ease of application, reliability, and so on.

Another key valuation issue is separating potential impacts from actual impacts. While some pollutants for example may be very harmful from a human health perspective, if they are discharged in locations where there is little human contact and no persistent effects, actual impacts may be small. Therefore it is important in identifying the context of impacts when assigning values, such as if changes in pollution loads will occur in metropolitan or sparsely populated regions.

Data sources, valuation assumptions and qualifications across each impact are summarised in the following sections.

Greenhouse Gases

To place an economic value on CO_2 emissions a shadow price of carbon is required. Shadow prices can be based on a preventative expenditure or damage cost approach.

For example, using a preventative expenditure approach and the recent price of certificates sold under the NSW Greenhouse Gas Abatement Scheme (GGAS), the shadow price of carbon could be estimated at $20 per tonne of CO_2. However as low cost opportunities for greenhouse gas abatement are used up, the marginal cost of abatement is likely to rise. With the foreshadowed introduction of a National Emissions Trading Scheme in Australia by 2010, many more activities will become liable for their greenhouse gas emissions and marginal abatement costs are likely to rise accordingly. While the ultimate design and hence liabilities under the scheme are still a work in progress, the National Emissions Trading Taskforce has cited a carbon permit price of around $35 per tonne CO_2e.

In this analysis a shadow price of $39.90 per tonne of CO_2 is used to be consistent with the figure used in the financial analysis of options as provided by ACT Treasury. Given the significant uncertainty over greenhouse gas values, sensitivity analysis is undertaken for a range of values.

Air and Water Pollutants (other than greenhouse gases)

Air & water emissions are associated with resource extraction, processing, transport and manufacturing sectors, as well as the handling or reprocessing of recyclates. Valuation of the impacts of those emissions would involve an assessment of environmental and health damage of each type of emission and estimation of the monetary value of damages. Because of the difficulty in quantification of non-market values and limited data available, pollution impact values have been postulated through benefit transfer techniques.

Importantly, pollution impact values will be significantly determined by their location and related population exposure, demographics, and other determinants of health and environmental impacts. As the majority of emissions associated with increased resource recovery are estimated to be associated with upstream processing activities, it is the pollution impact values at these locations that are pertinent. And as indicated later in this economic assessment, most recycling and displaced production based on virgin materials occurs in NSW, and predominantly in the metropolitan region.

Pollution impact values applicable to NSW have therefore been used in this analysis, and they are reported at Table 20. Derivation of these values is reported in McLennan Magasanik Associates and BDA Group (2007).[2]

Table 20 Assumed Emission Impact Values ($/tonne)

EMISSIONS TO AIR *(other than greenhouse)*	VALUE	EMISSIONS TO WATER	VALUE
Lead	$1,565,667	Nitrogen	$9,821
SOx (oxides of sulfur)	$313	Phosphorus	$290,360
Particulates	$2,562	Suspended solids	$11,102
NOx (oxides of nitrogen)	$8,967	Organic matter	$142
VOCs (volatile organic compounds)	$6,576	Zinc	$996
		Copper	$910,933

It should be noted that impacts from pollutants identified in the LCA and not included in Table 21 will not be captured in the economic assessment (apart from greenhouse gas emissions). The exclusion of most of these other pollutants from

2 McLennan Magasanik Associates and BDA Group (2007) South Australia's Waste Strategy 2005-2010: Ex ante benefit cost assessment

pollution discharge fees applied by State Governments to industrial premises suggests that the risks posed by these emissions may not be high. That is, the concentration of emissions discharged from regulated premises complying with pollution discharge regulations may not present a risk given the location of these premises and the likelihood of exposure to them by nearby populations.

The Productivity Commission recently cautioned that postulating potential health or environmental impacts merely because emissions of various pollutants could be identified was a fraught exercise without taking into account the risk and uncertainty as to actual impacts[3]. Nevertheless, to the extent that net reductions in other emissions are identified but not valued, estimated economic impacts may be underestimated.

Resource Savings

The value of resource savings arising from materials and energy recovery in recyclate are captured by observed market prices for the recyclate. At Table 21 the assumed market prices for recyclates are presented.

3 Productivity Commission 2006

Table 21 Market Prices for Recyclates

RECYCLATE	PRICE ($/TONNE)
Mixed paper	105
Glass containers	84
Aluminum cans	1,900
Steel cans	88
HDPE containers	675
PET containers	600
Mixed plastic/film plastic	250
Garden organics*	55
Food organics*	32
Concrete	14
Asphalt	18
Timber	21

*__Note__: This price has been developed from an output price taking into account the reduction in quantity as a result of the composting process.

There are lost opportunities associated with burying resources in landfill. However, no further 'resource' value to future generations of conserved virgin materials has been ascribed for inclusion in the economic assessment. This is the standard convention in economic assessments. Any interpretations as to the inter-generational equity of alternative resource use patterns can be made with reference to the resource inventories presented in our environmental assessment.

Illegal Dumping

There will be an increase in the price of waste disposal to landfill from some under the Options. Waste disposal gate fees will increase for the C&I and C&D sectors as well as for self-hauled domestic wastes compared to the Base Case. Under the Base Case the fees will be $100 per tonne by 2026 with this value increasing to $110 under Option 1 and $130 under Options 2, 3 and 4. This could potentially result in an increase in illegal dumping.

In order to estimate the potential costs of an increase in dumping the approach used in McLennan Magasanik Associates and BDA Group (2007)[4] for the estimation of the cost of illegal dumping in South Australia is used. The key assumptions for the approach are:

- the current level of illegal dumping is assumed to be around 1% of total waste disposed to landfill in the ACT;
- the cross price elasticity of illegal dumping with landfill gate prices is assumed to be 2; and
- the damages of illegal dumping are estimated using a clean up cost estimate of $300 per tonne.

7.2 Base Case and Options

This section provides a description of the Base Case and key options included in the TBL assessment. It also provides an assessment of the likely environmental impacts of the base case over the next 20 years.

7.2.1 Impacts of the Base Case - Under the base case, efforts to increase resource recovery cease and as a result the rate of resource recovery decreases from the current level of 75% to 56% over a 20-year period. Without continued resource recovery efforts an extra 1.2 million tonnes of waste would be landfilled over the 20-year period with associated environmental impacts of landfilling valued at around $9 per tonne or $10 million in total. The primary impact is the greenhouse gas emissions associated with landfilling (making up 99% of this total value).

7.2.2 Resource Recovery of Options - additional resources recovered over the Base Case under options over 20 years. At Table 22 the composition of the increase in resource recoveries under each option is shown. Option 5 has not been included as there is no increase in resource recovery compared to the Base Case.

4 McLennan Magasanik Associates and BDA Group (2007) South Australia's Waste Strategy 2005-2010: Ex ante benefit cost assessment

Table 22 Composition of Increase in Resource Recoveries Over the Base Case over 20 years

	Option 1	Option 2	Option 3	Option 4
MSW - dry recyclables	68,831	187,419	298,303	298,303
- garden	321,576	321,576	321,576	321,576
- other	8,122	8,122	8,122	8,122
C&I - dry recyclables	67,396	668,163	668,163	668,163
- garden	113,935	113,935	113,935	113,935
- other	189,929	189,929	189,929	189,929
C&D - timber	0	80,484	80,484	80,484
- other	410,421	571,389	571,389	571,389
Home composting	0	162,448	162,448	162,448
Source separated - MSW food to AWT	0	228,062	228,062	228,062
- C&I food to AWT	0	93,169	332,746	332,746
Mixed dry MSW to dirty MRF	0	0	283,258	467,913
Mixed dry C&I waste dirty MRF	0	0	0	444,478
Total recoveries	**1,180,211**	**2,624,696**	**3,258,415**	**3,887,548**

7.3 Economic Assessment

This section presents the results of the economic assessment for each option, a discussion of key drivers of costs and benefits of the options and the results of sensitivity analysis.

7.3.1 Net Benefits of Options - the results of the economic assessment are shown at Table 23. Options 3 and 4 are estimated to provide net benefits of $16m and $45m respectively over the 20 years. Option 1 provides a net benefit of only $0.4m and there is a net cost for Option 2 of around $10m. Exporting all waste to Woodlawn under Option 5 has a net cost of around $31m.

Table 23 Net Benefits Relative to the Base Case (20 year NPV $m)

OPTION	COSTS	BENEFITS	NET BENEFITS
Option 1	$56	$55	<$1
Option 2	$204	$193	-$10
Option 3	$250	$266	$16
Option 4	$302	$347	$45
Option 5	$56	$25	-$31

Note: Figures have been rounded to the nearest million.

The greatest benefit under Options 1 to 4 is the value of the additional recyclables recovered. However, the additional costs of collection, processing and transport of recyclables are greater than these market values under all options. Thus without consideration of environmental impacts recycling comes at a net cost.

For the options with greater levels of costs recovery, the environmental benefits of emissions avoided through the use of recovered material to displace virgin material production and avoided landfilling outweigh this net cost and Options 3 and 4 provide a significant net benefit.

7.3.2 Key Drivers of Benefits and Costs - the benefits of the options include the reduced costs of landfilling, value of additional recyclables recovered and reduced emissions from less landfilling and avoided production through the use of recycled rather than virgin materials. At Table 24 a breakdown of the estimated benefits of each option is presented.

Table 24 Benefits of Options Over Base Case (20 year NPV $m)

	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
Reduced operational costs of landfilling	$5	$14	$18	$21	$1
Avoided landfill cell construction costs	$13	$31	$46	$49	$23
Value of additional recyclables recovered	$24	$91	$127	$171	-
Reduced emissions from landfills	$5	$18	$22	$29	-
Reduced emissions from inputs/products displaced	$8	$40	$54	$77	-
Total benefits	**$55**	**$193**	**$266**	**$347**	**$25**

Note: Figures have been rounded to the nearest million.

The value of the additional recyclables recovered is critical to the analysis. Under Option 1 there is a substantial increase in recovery of garden organics from the domestic waste as well as dry recyclables. Under Option 2 the recovery of dry recyclables is substantially increased with around half of the value of additional recyclables relating to the value of paper recovered from the C&I sector.

Under Options 3 & 4 there is much greater recovery of dry recyclables through the dirty MRF processing. The values for the C&I sector relate mainly to paper and aluminum and for the domestic sector they are made up of a range of materials eg. paper, PET, glass, HDPE and aluminum.

The avoided landfill construction costs are also significant, but the bulk of these benefits appear to be achieved with the recovery levels under Option 2, and the level of benefits increases by a lower amount as recovery increases further. Under Option 5 the costs of landfill disposal decreases compared to the Base Case primarily because the capital costs of landfilling at Woodlawn are likely to be lower.

The benefit of reducing emissions by displacing production using virgin materials increases steadily under the options as the level of recovery increases. The most significant substances making up these benefits are avoided carbon dioxide and nitrogen oxides from paper, aluminum and PET production.

The costs of the options include increase costs of collection and sorting of recyclables and government programs, increased emission from reprocessing and increased costs of transport. Table 25 shows a breakdown of the estimated costs of each option.

Table 25　Costs of Options Over Base Case (20 year NPV $m)

	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
Cost of programs and new collection services	$14	$53	$53	$53	$0
Costs of sorting/treating recyclables and waste	$25	$93	$121	$151	-$2
Increased emissions from reprocessing of recyclates	$1	$10	$16	$23	-
Increased costs of transport of recyclates/waste	$13	$39	$52	$66	$58
Increased emissions from transport	<$1	$3	$4	$4	<$1
Increased costs of illegal dumping	$1	$4	$4	$4	-
Total costs	**$56**	**$204**	**$250**	**$302**	**$56**

Note: Figures have been rounded to the nearest million.

The bulk of the costs relate to the sorting/treatment of wastes. The steep jump in costs from Option 1 to Option 2 reflects the substantial increase in sorting of dry recyclables from the C&I sector. There are also increase costs of government programs and new collection services. The higher costs in Options 2, 3 and 4 reflect the cost of new bins and services for the separation of kerbside organics. The cost of transporting recyclates increases under Options 1 to 4. Under Option 5 the increased transport costs relate to the transport of waste to Woodlawn.

The emissions from reprocessing also increase with more recovery under each option. The most significant substances making up the costs of emissions are nitrogen oxides to air and suspended solids to water from reprocessing of paper.

The costs of transport emissions and illegal dumping are a relatively small component of the total costs. The estimated costs of illegal dumping are greater under Options 2, 3 and 4 as a result of higher gate fees.

7.3.3　Sensitivity Analysis - the results of sensitivity analysis on a number values are tested:

- value of greenhouse emissions
- value of other emissions
- market prices for recyclates

The greenhouse value has a significant impact on the net benefits of the Options, apart from Option 5. The impact of reducing the value to $20 per tonne CO_{2e} and increasing it to $60 per tonne is shown at Table 26.

Table 26 Impact of Greenhouse Value on Net Benefits (20 year NPV $m)

	$20	$40	$60
Option 1	-$4	$0	$4
Option 2	-$29	-$10	$8
Option 3	-$8	$16	$41
Option 4	$10	$45	$80
Option 5	-$31	-$31	-$32

At the lower value only Option 4 provides a net benefit, whereas at the higher value all options, apart from Option 5 provide a net benefit.

The value of the other air and water emissions also has an impact on the net benefits of Options. Table 27 shows the results of changing the anchor value of the pollutant values by 50%.

Table 27 Impact of Value of Other Emissions on Net Benefits (20 year NPV $m)

	- 50%	ANCHOR VALUE	+ 50%
Option 1	-$2	$0	$1
Option 2	-$13	-$10	-$7
Option 3	$12	$16	$21
Option 4	$40	$45	$50
Option 5	-$31	-$31	-$32

The market prices for recyclates are also critical to the analysis as they provide the largest component of benefits under the Options with increased recovery. An example has been examined where the market prices assumed for the ACT are substituted with values used recent in waste management analyses from other states. The results are shown at Table 28.

Table 28 Impact of Market Prices for Recyclates on Net Benefits (20 year NPV $m)

	WA/SA MARKET RATES*	ACT MARKET RATES
Option 1	-$9	$0
Option 2	-$34	-$10
Option 3	-$14	$16
Option 4	$7	$45
Option 5	-$31	-$31

*__Note__: market rates for WA/SA are drawn from recent waste management studies for those states. The rates are lower for some materials eg. organics, glass, timber and aluminum and higher for other materials eg. steel, paper and HDPE.

Only option 4 provides a net benefit under this scenario – highlighting the sensitivity of the results to these prices.

At Tables 29, 30 and 31 the sensitivity of the results to individual market prices for three key recyclates: aluminum, paper and organics are presented

Table 29 Impact of Market Price for Aluminum on Net Benefits (20 year NPV $m)

	- 50%	$1,900	+ 50%
Option 1	-$1	$0	$1
Option 2	-$19	-$10	-$1
Option 3	$6	$16	$27
Option 4	$29	$45	$61
Option 5	-$31	-$31	-$31

Table 30 Impact of Market Price for Paper on Net Benefits (20 year NPV $m)

	- 50%	$105	+ 50%
Option 1	-$3	$0	$2
Option 2	-$28	-$10	$7
Option 3	-$8	$16	$41
Option 4	$8	$45	$81
Option 5	-$31	-$31	-$31

Table 31 Impact of Market Price for Organics* on Net Benefits (20 year NPV $m)

	- 50%	$55 GARDEN $32 FOOD	+ 50%
Option 1	-$6	$0	$5
Option 2	-$20	-$10	$0
Option 3	$4	$16	$29
Option 4	$33	$45	$57
Option 5	-$31	-$31	-$31

*__Note__: Both garden and food

From Table 29, it is clear that the market price for paper has a substantial impact on net benefits. This is very important to the results because paper makes up 60% of the domestic recyclables and 75% of the C&I recyclables.

7.3.4 Uncertainties - the predictions of quantities of different types of resources recovered under different options have been taken directly from the financial review and assessment of strategy options.

The economic assessment assumes that the costed programs are effective in delivering the targeted levels of resource recovery. The benefits of the options will vary depending on how effective the programs are in practice.

The economic assessment also assumes that markets are available for all resources recovered and that the market prices for recyclates discussed earlier are maintained over the period of the analysis. The benefits of the options will vary depending on the strength of these markets and material prices.

It has not been possible to quantify the environmental benefits of all avoided production or the environmental costs of all reprocessing activities. However, the major impacts have been captured by drawing on the results of the Life Cycle Analysis Australian Data Inventory Project April 1999 by RMIT and the Cooperative Research Centre for Waste Management and Pollution Control, the Life Cycle Assessment for Paper and Packaging Waste Management Scenarios in Victoria January 2001 by RMIT and the Cooperative Research Centre for Waste Management and Pollution Control and the National Pollutant Inventory database.

7.4 Environmental Indicators

The changes in resource use and emissions under each option arise from:

- avoided resource use and air and water emissions as recyclates displace production with virgin materials;
- increased resource use and air and water emissions from the reprocessing of recyclates;
- avoided air emissions through diversion of waste from landfills;
- increased air emissions from the transport of recyclates.

This section discusses the net changes for resource use, air emissions and water emissions separately below and highlights the key materials driving these results.

7.4.1 Changes in Resource Use - the analysis suggests substantial savings in resources a result of recyclates displacing virgin material production. At Table 32 the key savings are summarised including in energy, water, wood, oil and iron. Option 5 is not included because there is no change in the use of recyclates compared to the Base Case.

Table 32 Net changes in Resources Use Relative to the Base Case (total tonnes over 20 years)

	OPTION 1	OPTION 2	OPTION 3	OPTION 4
Energy GJ	-617,088	-3,888,210	-5,794,824	-8,433,422
Sand	-15,616	-70,065	-137,552	-194,431
Bauxite	-10,856	-89,711	-103,979	-165,829
Coal	10,520	54,001	94,053	136,071
Iron	-2,288	-9,744	-20,046	-28,095
Soda ash	-3,034	-13,612	-26,722	-37,772
Lignite	15,573	81,984	139,640	202,952
Lime	-5,044	-23,673	-44,643	-63,582
Oil	-5,706	-25,969	-50,340	-71,324
Wood	-136,448	-909,495	-1,262,449	-1,921,179
NA_2SO_4	-137	-613	-1,204	-1,702
Feldspar	-31	-141	-276	-390
Water	-5,138,243	-41,540,805	-49,025,540	-77,798,487

A range of materials contribute to the savings in energy use, with the greatest savings from avoided production of aluminum. The biggest contributors to water savings are avoided paper and aluminum production. The majority of the increased use of coal and lignite results from the reprocessing of paper.

7.4.2 Changes in Air Emissions - the reduction in emissions of greenhouse gases under the options results from reduced landfilling, recyclates displacing virgin production. Table 33 shows that these reductions are likely to be far greater than the increases resulting from reprocessing and the transport of recyclates. Different factors contribute to this result under the different options.

For Option 1 reduced landfilling provides around 75% of the greenhouse gas emission reduction benefits, whereas under Option 4 reduced landfilling only contributes around 40% of the benefit. For Option 5 the only changes in air emissions relate to the increased emissions from transport of waste to Woodlawn for disposal.

Table 33 Net Changes in Air Emissions Compared to the Base Case (total tonnes over 20 years)

	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
CO_2-e*	-552,688	-1,828,697	-2,298,992	-3,236,532	98,966
Sox	0	0	0	0	0
Particulates	17	-75	125	107	31
Nox	-439	-1,210	-1,606	-2,180	200
VOCs	-197	-900	-1,327	-1,959	63
Other	-28	-107	-162	-238	386

***Note**: CO_2-e includes carbon dioxide, methane and nitrous oxides

The substitution of a range of recyclates for virgin material production avoids emissions of a range of air pollutants, with the greatest benefits from avoided production of paper, aluminum and PET. In the case of sulfur oxides, the higher emissions from reprocessing of paper outweigh the emissions avoided from aluminum and paper production for some options.

7.4.3 Changes in Water Emissions – under the options there is an increase in recyclates displacing steel and paper production which avoids emissions to water of suspended solids, organic matter and other pollutants, such as oils and greases, chlorine and sulfate. However, the reprocessing of paper also results in emission of suspended solids, organic matter and other pollutants.

Table 34 shows that increased recycling results in a net increase in emissions of a number of pollutants to water. However there is a reduction for some individual pollutants such as zinc, as a result of compost displacing the use of phosphate fertilisers. Option 5 is not included because there is no change in water emissions compared to the Base Case.

Table 34 Net Changes in Water Emissions Compared to the Base Case (total tonnes over 20 years)

	OPTION 1	OPTION 2	OPTION 3	OPTION 4
Suspended solids	38	271	354	547
Organic matter	1,182	7,896	10,938	16,654
Zinc	0	-2	-4	-5
Other	27	327	276	489

7.5 Social Indicators

This section reports on a range of social indicators relevant to ACT community for the assessment of options under the ACT NOWaste strategy. These include:

- financial impacts on the ACT governmen and on ACT households
- job creation
- private sector business growth
- environmental benefits.

The financial impact on the ACT government, the job creation and the business sector growth projections were all presented at Section 5 above.

Financial impacts on ACT households include the cost of new bins and services for kerbside organics under Options 2, 3 and 4 and the increase in the price for self-haul disposal of waste to landfill of around 10% under Option 1 and 30% under Options 2, 3 and 4.

The total financial costs are estimated at around $4.3m as a one-off cost of new bins and $3.3m per annum for around 130,000 households for the collection service for kerbside organics. The increase in gate fees is estimated to have a financial impact of around $150,000 per annum under Option 1 and $460,000 per annum under Options 2, 3 and 4.

The options have a range of environmental impacts on the ACT community including the benefit of reduced emissions from landfilling within the ACT and the cost of emissions from transport of waste and recyclates. At Table 35 the value of those impacts are summarised, with the benefit of avoided emissions from landfills outweighing the emissions from transport.

Table 35 Net Environmental Benefit for ACT Community (20 year NPV $m)

	OPTION 1	OPTION 2	OPTION 3	OPTION 4	OPTION 5
Benefit of reduced emissions from landfilling	$5.4	$17.5	$22.3	$28.9	$13.9
Cost of emissions from transport of recyclates	$0.1	$0.3	$0.4	$0.4	$0.0
Cost of emissions from transport of waste to Woodlawn	$0.0	$0.0	$0.0	$0.0	<$0.1
NET BENEFIT	**$5.3**	**$17.2**	**$21.9**	**$28.5**	**$13.9**

ATTACHMENT 1. Structure and Assumptions of Financial Evaluation

The financial evaluation was conducted using Microsoft Excel spreadsheets. A complete suite of the spreadsheets and worksheets used for the evaluation has been supplied in electronic format appended to this report. All of the data sources used for the financial evaluation have been included on the electronic file, however, only the key sources which contain data that was expected to change during the course of the review have been linked in the working spreadsheets.

The following notes describe the main spreadsheets that have been used for the evaluation, and then the construct of the central financial model.

File: ***ACT NoWaste Modelling.xls*** – this file was generated by WCS and contains the detailed financial modelling for the evaluation and draws on linked data from subordinate files either supplied by ACT NOWaste or generated by WCS.

The various worksheets within this spreadsheet are described below.

File: ***Pop & GDP.xls*** – this file was generated by WCS and contains historical and forecast data for population and waste data for the ACT. Data from this file is linked into the main modelling file for waste generation trends and population statistics.

Over 12 years of historical waste generation and resource recovery data were used. Correlations between waste generation rates and both population and state GDP indicated that population based trends were likely to be more reliable. In addition, 20-year forward forecasts of State GDP were not available, where as long-term forward forecasts of population were available.

Waste generation and recovery data were therefore analysed on a per capita basis.

The population based waste data was analysed to develop medium-term trends in both generation and recovery and to calculate rates of change for those trends – i.e. second differentials of the prime data.

Combining the trend indicators with the second differential provided a reasonable basis for forward forecasting total waste generation.

File: ***Commercial-Domestic Data Split.xls*** – this file was supplied by ACT NOWaste and contains historical data on the inventories of waste composition to landfill and resources recovered for the past 12 years. Some elements of this file are linked into the main modelling file where splits were required between waste sources.

This data was subsequently reviewed by ACT NOWaste on the basis of visual audits on C&I waste sent to landfill, and the flies named *combined-estimate-landfill-waste-composition.xls* and *code12commercial-composition-grouped.xls* were also supplied by ACT NOWaste as updates and used for waste recovery modelling – but not linked into the main spreadsheet.

File: ***Landfill Cell Cost Model.xls*** – this file was created by WCS to model the cost of landfill activities, including planning and land acquisition, capital works, operating costs, closure costs and post closure maintenance costs.

Data for this spreadsheet was obtained through several sources including:

- a workshop between WCS and ACT NOWaste to analyse the current costs and allocations in the departmental budgets for landfill activities;
- an earlier study commissioned by ACT NOWaste into the full cost of landfill activities (now considerably out of date), and
- internal data from WCS drawn from assignments completed for various clients on landfill management.

Data from this model was linked into the main model to provide costs for landfill activities.

File: ***Full Data Summary.xls*** – this file was supplied by ACT NOWaste and contains historical data on waste dispatched to landfill and resources recovered. Some elements of this file are linked into the file used for modelling population and waste generation.

File: ***ACT NoWaste Modelling.xls*** – as mentioned above, this file is the main spreadsheet for the modelling on which the financial evaluation is based. Below the main worksheets are described and how they relate to the modelling.

Worksheet: ***Demog & Waste*** – this worksheet uplifts data from the various source files to establish the base-line demographics and waste quantities for the full 20-year model.

The base line waste data presents forecasts of both sources (Domestic, C&I, C&D) as well as destinations (resource recovery, landfill etc) on an underlying "do nothing" assumption, i.e. it is a forecast of how the various waste flows might unfold into the future if no further actions were taken from 2007/08 onwards to influence the recovery of resources.

Charts are presented of the various streams of materials, and these clearly show that waste recovered will decline over time and that the amount of waste going to landfill will approach 50% by the end of the 20-year modelling period (double the 26% recorded in 2006/07).

This data represents the basis against which interventions (Options) are estimated.

Worksheet: Cost-Cap – this worksheet contains the basis for capital cost estimates. It draws data from the ACT NOWaste budget documents, but is not linked to that file, and from the landfill cost model, to which it is linked.

Elements of capital costs are set out separately and a marker is used to indicate when a cost element is applicable to a specific option. Capital cost elements are summed for each option based on the relevance flagging.

The capital costs for each option are fed forward to the Financial Model worksheets.

Worksheet: Cost-Operate – similar to the capital cost worksheet, this worksheet models operating costs globally, allocates them to the various options, and then feeds the total operating cost for each option forward to the Financial Model worksheets.

Worksheet: Revenues – similar to the capital cost worksheet, this worksheet models revenues globally, allocates them to the various options, and then feeds the total operating cost for each option forward to the Financial Model worksheets.

Worksheets: Tonnes – for each of the Base Case, and Options 1, 2, 3, & 4 these worksheet contain the models of waste flows for interventions with various initiatives. The format of these worksheets is the same, as are the formulae in each.

The resource recovery target for each option is set manually at row 153, while rows 154 to 156 show progress in achieving the desired target through implementation of various diversion and recovery initiatives.

The waste flow models are "driven" by the waste diversion and resource recovery initiatives that are set out from row 117 and by the implementation timing for these initiatives set out from row 160. The initiatives are turned "on" or "off" at rows 117 to 132, where the quantum of the initiative is also set. Timing for the build-up in achieving the full quantum of the initiative is established at rows 160 to 174.

These worksheets draw base waste flow data from the Base Case worksheet, and each is adjusted by the tonnages in the waste diversion and resource recovery initiatives tables.

On the worksheet for the Base Case at Cell B5, an option is provided to include or exclude waste generation growth in the modelling.

Each option worksheet is accompanied by a chart plotting tonnes generated, tonnes recovered and tonnes disposed.

Waste flow data for each option is then fed forward to the Financial Model worksheet for each option.

Worksheets: Financial Model - for each of the Base Case, and Options 1, 2, 3, & 4 these worksheet contain the models of waste flows for interventions with various initiatives. The format of these worksheets is the same, as are the formulae in each.

The financial models draw in waste flows and cost data, extended over the 20-year period of the model and compute net present values for the cash flows using a discount rate that is set on the Base Case Financial Model worksheet at cell C52.

Results from the Financial Model worksheets are fed forward to the worksheet labelled **Summary of Option Costs**.

Worksheets: Initiatives Testing – a separate financial model was established for the various initiatives discussed in Chapter 4, one at a time. On the tonnage worksheet, each initiative is modelled and the resulting financial implications are modelled on the corresponding financial worksheet. The results from the financial worksheet are transferred to the summary worksheet and manually transposed into the summary table. This process can be repeated initiative by initiative.

The accuracy of the initiative testing model was checked by summing (stacking) the results for all initiatives for particular option and comparing the "stacked" result with that for the option as modelled previously.

Via these worksheets, it has been possible to obtain an estimate of the recurrent budget implications for ACT NOWaste for implementing each initiative individually.

Assumptions Used for Modelling

GST

Financial model data has been estimated excluding allowance for GST – i.e. landfill gate fees do not include the GST component charged to clients.

City Growth

Budgets prepared by ACT NOWaste have historically included a revenue line item called City Growth. This revenue from Treasury is sought to offset annual increases in the costs to provide regular contracted services to residential customers such as:

- additional collection services that are required as new households are built and occupied, and
- collection contract escalation covering fuel, labour and materials.

In the budgets, the City Growth revenue line item is offset by additional costs that are built into the cost forecasts for each year.

The financial modelling undertaken for this project does not include provision for inflation factors. Therefore, the City Growth revenue item is omitted from the models, because the costs that this revenue item is intended to offset are equally not included in the models.

Forecasting Revenues from Queanbeyan Waste Flows

The gate fee used to estimate revenues from Queanbeyan waste is the published gate fee at the landfill less GST. For the purposes of the financial models, this relationship will be assumed to continue, so long as Queanbeyan waste is dispatched to landfill, and shown as a revenue line item in the models.

Queanbeyan waste is treated in a similar fashion to ACT domestic waste. On this basis, when ACT domestic waste is diverted from landfill to processing, it will be assumed that the same applies to Queanbeyan waste and the revenue for processing of this waste is calculated at the gate fee cost for processing.

Historical data on the amount of recyclables received and processed in the ACT from Queanbeyan has not been received for analysis. However, budget data appears to indicate that the revenue received for processing recyclables equates to approximately 22% of that received for landfill disposal of residual waste.

For the purpose of financial modelling, it is assumed that this will continue to be the case.

Landfill Disposal Costs

The history of land-based disposal of waste in the ACT is one where the real cost of landfill disposal has rarely been crystallised or paid.

Prior to the 1970's waste disposal took advantage of available quarries, gullies and holes in the ground with little regard for environment protection, with poor or no capping relative to the standards expected today. In the mid 1970's Mugga Lane and West Belconnen sites were opened, initially using unlined trenches to receive waste, later moving to purpose excavated, but unlined cells.

By the mid- to late 80's, the use of limited clay lining was introduced, some leachate capture was implemented and post-closure gas capture introduced. Landfill activities continued using these broad management techniques through to the first half of the present decade.

In 2005/06, synthetic lining of cells was introduced at Mugga Lane, gas capture was contemporaneous with landfilling and more pro-active leachate management was implemented.

However, thus far the more recent cells developed at Mugga Lane have benefited from the pre-existence of fully or partially excavated voids. This circumstance continues today, with the current new cell that is due to go into production in the 2007/08 financial year being formed within an existing borrow pit.

On this basis, the landfill costs experienced in the ACT are not reflective of the full cost to develop a virgin site and to manage that site according to the latest regulatory requirements for day to day environment management, closure and post closure maintenance.

Accordingly, it has been considered inappropriate to base future landfill cost estimates on historical data. Therefore, new cost estimates have been developed for securing a virgin site, developing the site, managing the landfill operations, capping and closing the site, and managing the site for some 50 years after closure. These estimates were developed collaboratively by staff of ACT NOWaste and Wright Corporate Strategy, drawing on the combined experience of the parties. These estimates were compared with other broad-based assessments prepared for ACT NOWaste by other specialists at various times in the past and found to be representative of the full cost profile for state-of-the-art landfills today in Australia.

Landfill Gate Fees

The 2007/08 landfill gate fee charged by ACT NOWaste is $90 per tonne. This fee has been progressively raised over recent years, with the specific intent of bring the cost of disposal to waste generators more closely in line with the cost of processing technologies for the recovery of resources from waste streams – for example recovery of dry recyclables for the C&I waste stream in a materials recovery facility.

It is the stated intention of ACT NOWaste to have the landfill gate fee elevated to the equivalent fee level required for processing mixed waste in an alternative waste processing facility, in time for the introduction of AWT. The table below presents the sequence of gate fee increases used in the modelling.

LANDFILL GATE FEE INCREASE DATES ($ PER TONNE)

	2007/08	2008/09	2009/10	2010/11	2011/12
BASE CASE	$90	$100	$100	$100	$100
OPTION 1	$90	$100	$110	$110	$110
OPTION 2	$90	$100	$110	$120	$130
OPTION 3	$90	$100	$110	$120	$130
OPTION 4	$90	$100	$110	$120	$130

The assumption inherent in the foregoing is that where there is no introduction of significant initiatives to increase resource recovery above current levels, there is no market justification for further increase in landfill gate fees.

Operating and Capital Costs

Policy and Intervention Costs

The Strategy – *Turning Waste into Resources* - comprised six strategic planning categories, nine programs and twelve sub-programs. These were set out in the Strategy document and discussed in terms of outcomes sought, potential timeframes for implementation, resources required, estimated budget impacts and approaches to measurement of achievements.

Those cost estimates have been uplifted and augmented where appropriate to provide current estimates of resource costs (people and materials) likely needed to implement and provide on-going support for each category. At the table below the strategic planning categories and costs are set out and allocated to each of Options 2, 3 and 4.

For the Base Case modelling, provision was made to fund only the regulatory and monitoring program areas, while for Option 1 the total program funding allocation was capped at $500,000 p.a.

Application of Policy & Intervention Costs

CATEGORY	INITIAL COST ($mill)	ON-GOING ANNUAL COST ($mill)
Leadership and advocacy	$0.295	$0.065
Community engagement	$0.195	$0.475
Infrastructure and services	-	$0.175
Regulation and incentives	-	$0.200
Research and development	-	$0.225
Monitoring, review and reporting	-	$0.050

Landfill Infrastructure Costs

Mugga Lane Landfill. A recently created waste disposal cell due to come on-line for 2007/08 has capacity for 1.8 million cubic metres of waste, which amounts to eight years disposal at an input rate of 192,000 tonnes per year (approximately 1.53 million tonnes).

Following completion of this cell, there is limited further space at the existing Mugga Lane facility as the final land-form on the eastern side of the ridge will be completed. On this basis, new landfill arrangements will be required. It is assumed that these capital works will be funded by ACT NOWaste and operated on contract arrangements inline with those currently in place.

The landfill procurement scheme incorporated into the models is land acquisition and landfill development elsewhere within the ACT for a series of 2 million cubic metre (1.7 million tonne) capacity landfill cells to be developed and commissioned as demand for landfill space requires.

The table below presents a summary of total landfill demand for each option and a forecast of when new landfill capacity will be required to be operational for each of the four options.

Landfill Cell Demand

	Cumulative Disposal Capacity Created (mt)	Base Case	Option 1	Option 2	Option 3	Option 4
20-Year Demand for Disposal (mt)		6.25	5.07	3.43	2.69	2.06
Existing Mugga cell	1.53	2013/14	2013/14	2015-16	2016/17	2018/19
1st New 2 m CuM cell	3.23	2019/20	2019/20	2025/26	4 yr rem	15 yr rem
2nd New 2 m CuM cell	4.93	2023/24	2025/26	8 yr rem		
3rd New 2 m CuM cell	6.63	2026/27.	5 yr rem			
4th New 2 m CuM cell	8.33	3 yr rem				

New landfill facility estimated costs for a notional 2 million cubic metre cell are as follows:

Capital

- Land acquisition: $2.964 million (with space for up to five cells)
- Development planning: $1.525 million.
- Construction of landfill facility: $26.351 million.
- Future closure cost: $8.680 million.

Operating costs

- Contract operations: $1.531 million per annum fixed plus $3.002 million per annum variable (based on starting waste volume of 200,000 tpa).
- Post closure maintenance: $0.120 million pa for 50 years per cell closed.

Parkwood Road Landfill. The former landfill at Belconnen has reached close to its full capacity and its further use for disposal is not proposed for any option.

Closure and post-closure management costs are a requirement for all options.

- Closure costs - $8.680 million.
- Post closure costs - $0.120 million pa for 50 years.

While the assumption has been made that a new site will be used for future landfill activities, without knowing a likely location it is not feasible to postulate on issues such as access and transfer. Therefore, no additional allowance has been made for transfer stations or transport costs.

Other Public Infrastructure

All other public infrastructure is assumed to be of sufficient capacity to cover the project period for all options without major capital works expansion.

Operating and Contract Costs

All options would result in a continuing future costs associated with maintenance of current services such as kerbside collection, receipt and transfer of materials at transfer stations etc. Costs for these activities have been extracted from the ACT NOWaste 2007/08 budget estimates for use in the modelling.

Revenue Estimates

The ACT Government receives three broad income streams relating to waste services available to residents and business:

- rates from residents from which costs to cover the cost of collecting, processing and disposing of metropolitan recyclables and mixed residual waste are derived;

- landfill gate fees received for:
    - disposal of business (C&I and C&D) waste (assessed at $9.9 million for 2007/08 based on a current gate fee of $90 per tonne and 110,000 tonnes),
    - disposal of waste sourced from Queanbeyan (assessed at $0.6 million for 2007/08), and
    - self-hauled residential waste received at ACT NOWaste facilities including Mugga Lane landfill (assessed at $1.5 million for 2007/08);

- other revenue:
    - acceptance fees for recyclables received from Queanbeyan (assessed at $0.13 million for 2007/08),
    - royalties, rent and charges (assessed at $0.620 million per year), and
    - departmental revenue for lease of old site, extra services, and non-standard services (assessed at $2.4 million for 2007/08).

Allowance for these revenue sources, excluding rates for domestic waste services) has been made in the financial modelling.

Attachment 1 - Financial Spreadsheets

Attachment 3 - Financial and Economic Models

See the CD on inside back cover