Final

Anglesea Landfill future options assessment

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PREPARED FOR

Surf Coast Shire

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Abbreviations & glossary

BPEM	Best practice environmental management
BSWWRRG	Barwon south west waste and resource recovery group
BSWWRRIP	Barwon south west waste and resource recovery implementation plan
EPA	Environment Protection Authority
NPV	Net Present Value
SCS	Surf Coast Shire
SCSC	Surf Coast Shire Council
TBL	Triple bottom line (an assessment of financial, environmental and social outcomes)

Executive Summary

Surf Coast Shire Council (SCSC) engaged Blue Environment to investigate and compare future options for the development, closure and rehabilitation of Anglesea landfill.

The landfill has airspace to last until 2021-2024 depending on the effectiveness of waste reduction strategies and on-site efficiencies. SCSC wants to know whether cost-savings could be achieved by closing the landfill earlier (in 2018) and sending wastes to alternative landfills.

Blue Environment considered the development, closure, rehabilitation and post-closure management of Anglesea landfill and compared this with the likely cost of transporting wastes to more distant landfills. The comparative analysis identified potential alternative landfills and estimated the costs of transfer (where bulk-haul consolidation of loads will be more efficient), transport and the expected gate fees at the different landfill sites. These costs were compared to the costs of continuing to operate the Anglesea landfill until it is full.

The following waste generation and management options were considered:

- 'Business as usual' landfilling with the extension of the landfill site, and closure in 2021-22 This assumes growth in landfilled waste in line with population with no reductions in landfilled waste or efficiencies in landfill operation.
- Extension of the landfill, with waste reduction, diversion and efficiency measures extending the life of the landfill to 2023-24.
- Early closure of the landfill in 2017-18, with all currently landfilled waste transported to alternative sites.
- Early closure of the landfill in 2017-18 with waste reduction measures reducing the need to transport all waste to alternative landfills.

The assessment concluded:

1. The preferred option is to continue filling the remaining landfill airspace and working to extend the life of the landfill by diverting more waste from landfill and increasing the effective filling rate[1]. This could see the landfill remain in operation until 2024.
2. Opportunities to divert waste include: introduction of a kerbside food organics and garden organics (FOGO) service; diversion of clean fill; diversion of more small vehicle and uncompacted commercial and industrial wastes by promoting greater separation at source. This could potentially include 'drop and sort' recovery, and diversion of street sweeping waste for drying, screening and reuse as a soil for landfill rehabilitation and site maintenance.
3. The estimated cost of the preferred option is an average per tonne cost of $106 per tonne, and a net present value (NPV) of $22.2 million inclusive of landfill levy over the next ten years.
4. Business as usual landfilling with no reduction in per capita landfilled waste and growth in landfill in line with population growth would see the landfill close in 2021, with an average cost of $141 per tonne and an NPV of $30.0 million inclusive of levy over the next ten years.
5. Early closure options will be more expensive because the costs of transfer, transport and gate fees at alternative landfills exceed the estimated costs of the Anglesea landfill operation.

[1] The 'effective filling rate' is the tonnes of waste deposited per cubic metre of landfill airspace. The rate can be increased (i.e. increasing waste deposited per cubic metre of airspace) through practices such as use of less or alternative daily cover or increasing compaction rates)

6. Early landfill closure with 'business as usual' landfilling of waste and growth with population would result in average costs of $164 per tonne and an NPV of $32.6 million between 2017 and 2027.
7. The option of early closure with a reduction in landfilled waste through the introduction of a FOGO service, diversion of clean fill, greater recovery from non-putrescible loads of residential and C&I waste, and diversion of street sweepings is estimated to cost an average of $162 per tonne of all waste managed, and have an NPV of $29.7 million inclusive of levy over the next ten years.
8. Risks associated with early closure of the landfill include:
   - Commercial and financial risks of waste transport and landfill gate fees increasing significantly above consumer price index (CPI). Transport costs are to an extent linked to fuel prices and greater than CPI increases in transport fuel can increases costs. Landfill gate fees charged by alternative sites could increase within the next 10 years, as closure of some landfills in Melbourne's south east increases demand and reduces competition for landfills in Melbourne's west.
   - Regulatory risk/costs associated with developing a new landfill masterplan for Anglesea and gaining EPA approvals for final contour and rehabilitation of the site. In addition to cost of developing new plans and managing the approval process, there is risk EPA may place additional requirements on the site. The 'void' that would be created if the final stages of the landfill are not developed would need to be managed to prevent pooling of stormwater that could percolate into landfill.
   - Loss of investment already made in development of the piggyback liner.
   - Early closure will not avoid most of the costs associated with rehabilitation and post-closure management of the site. Early closure of the landfill will only partially reduce the need for final liner and rehabilitation because the piggyback liner area overlies historically landfilled materials. It will not avoid the need for gas mitigation and upgrade of the leachate management system.
   - Increased heavy traffic from Surf Coast to other areas, with associated health and safety and pollution impacts.
   - If the landfill closes early, rehabilitation and post-closure management costs will be brought forward, without opportunity to recoup costs from commercial users through landfill gate fees. This will effectively put these costs onto rate payers either through a direct increase in rates for capital works or through an addition to the waste management service charge.
9. Risks associated with keeping the landfill open include:
   - Greenhouse gas and pollution risks associated with the additional cell. The new cell will meet EPA Best Practice Environmental Management (BPEM) requirements and have levels of environmental engineering superior to what has been required historically. This means waste deposited in the new cell poses less risk than waste landfilled historically, and early closure will not greatly reduce environmental risks associated with the site. The levels of engineering required for the new cell mean the site will have levels of environmental risk comparable to alternative landfills.
   - EPA could increase requirements for landfills that add to costs. Given the relatively recent approvals of the licence and updating of BPEM guidelines, this is considered unlikely during the remaining life of the landfill.
10. The greenhouse gas abatement benefits of sending waste to a landfill with gas energy recovery will depend on the rates of gas recovery at Anglesea and the alternative landfill. EPA requirements for landfill gas recovery and oxidisation, as well as the proposed capping of site and monitoring of surface gas concentration levels should result in at least 65% gas recovery and oxidisation once the final cap and gas recovery system are in place. Sending putrescible waste to

landfills with higher levels of gas capture and energy recovery could effectively reduce emissions by a further 15-35% (i.e. achieve net abatement of 80-100% including 'offsets' of fossil fuel power by energy generated from landfill gas). There would be some minor increase in greenhouse emissions under the early closure options due to increased transport distances. Diversion of organic wastes from landfill will reduce greenhouse gas emissions as well as other pollution risks.

11. Other pollution risks are likely to be similar regardless of whether Anglesea or alternative landfills are used as they will be subject to the same EPA best practice requirements for liners, capping, leachate management and site monitoring.
12. Although early closure would reduce heavy traffic on roads to the Anglesea landfill, this would more than be matched by negative impact of increase of heavy traffic on roads to a bulk haul transfer station and large loads to receiving landfills.

Early closure of the site will not significantly reduce environmental risks or greatly reduce rehabilitation and post-closure management costs. The cost assessment suggests there is no financial advantage in early closure because of higher transport costs to alternative landfills.

It is recommended SCSC continues to develop and operate Anglesea landfill to use available capacity approved under the recently updated EPA licence, and work to extend the life of the site through greater diversion of materials and improved effective fill rates. This will deliver the best value outcome.

1. Introduction

This report details work undertaken to assess future options for the management of Anglesea landfill.

Surf Coast Shire Council (SCSC) has operated the EPA licensed Anglesea landfill since 1974. The site was upgraded following a 2012 report (Fox Lane Consulting 2012), with investment in a 'piggy back' liner over formerly filled and unfilled areas to create additional filling capacity. The piggy back liner has been installed in stages, and two remaining stages are required to extend the life of the landfill within the next four years with an estimated cost of $2.4 million.

The site will also incur costs associated with capping, rehabilitation and post-closure management, including an upgrade of leachate management systems and installation of gas collection and oxidisation systems.

In addition to the Fox Lane report, SCSC developed the *Anglesea Landfill Masterplan, 2014 – Staged development, closure and rehabilitation* document that details and costs the proposed staged development and rehabilitation requirements of the site. This is reflected in the current EPA licence (2017) which provided EPA approval of the proposed Masterplan and final contours of the site.

SCSC has engaged Blue Environment to assess whether extension of the landfill is the most cost-effective option, or whether earlier closure of the landfill and transport of wastes to alternative landfill would reduce costs. The report considers alternative landfills that could serve the Surf Coast Shire community, as well as opportunities to reduce the need for these. Consideration is also given to greenhouse gas emissions and other social and environmental risks under different options.

Anglesea landfill currently receives 28,000 tonnes per year. Depending on the success of waste reduction, resource recovery and site efficiency measures, the site is expected to close between 2021 and 2024. Options that could extend the life of the landfill are considered in this report.

This report uses data provided by SCSC as well as independent costings of future landfill, transfer station and transport costings to compare the expected costs and performance of the following options:

- 'Business as usual' landfilling with the extension of the landfill site, and closure in 2021/22. This assumes growth in landfilled waste in line with population with no reductions in landfilled waste or efficiencies in landfill operation.
- Extension of the landfill, with waste reduction, diversion and efficiency measures extending the life of the landfill to 2024/25.
- Early closure of the landfill in 2018/19, with all currently landfilled waste being transported to alternative sites.
- Early closure of the landfill in 2018/19, with waste reduction measures reducing the need to transport all waste to alternative landfills.

2. Waste and cost assumptions

Blue Environment used and reviewed information provided by SCSC about likely waste generation and landfill development, closure and rehabilitation costs. We also used the 2012 Fox Lane report, the 2014 Anglesea Landfill Masterplan, and more recent capital works budget estimates and waste data provided by council. Blue Environment modelled the expected costs of using alternative landfills, with consideration of transport, transfer, bulk haul and expected gate fees at alternative landfills SCSC could potentially use.

2.1 Assumed growth in population

Profile ID data for assumed population growth have been used to estimate growth in waste generation. It was assumed per capita waste generation will remain constant, but greater resource recovery may occur.

Expected growth in population is shown in Tables 1 and 2. This shows rapid growth in the Torquay area, strong growth in Jan Juc-Bellbrae-Bells Beach Winchelsea, and more modest growth in other areas in the Shire.

Table 1: Assumed population growth (capita)

Area	2016	2021	2026	2031	2036
Anglesea	2,653	2,760	2,789	2,808	2,847
Dean Marsh and Moriac Districts	4,453	4,533	4,640	4,763	4,902
Jan Juc-Bellbrae-Bells Beach	4,839	5,309	5,517	5,845	6,374
Lorne-Aireys Inlet	2,579	2,715	2,845	2,958	3,076
Old Torquay-Torquay West	5,899	6,809	7,641	8,431	9,566
Torquay North	6,714	8,307	10,287	12,323	13,786
Winchelsea	2,208	2,404	2,663	2,943	3,211
Surf Coast total	**29,345**	**32,837**	**36,382**	**40,071**	**43,762**

Table 2: Assumed population growth (% increase)

Area	2016	2021	2026	2031	2036
Anglesea	-	4.0%	1.1%	0.7%	1.4%
Dean Marsh and Moriac Districts	-	1.8%	2.4%	2.7%	2.9%
Jan Juc-Bellbrae-Bells Beach	-	9.7%	3.9%	5.9%	9.1%
Lorne-Aireys Inlet	-	5.3%	4.8%	4.0%	4.0%
Old Torquay-Torquay West	-	15.4%	12.2%	10.3%	13.5%
Torquay North	-	23.7%	23.8%	19.8%	11.9%
Winchelsea	-	8.9%	10.8%	10.5%	9.1%
Surf Coast total	**-**	11.9%	10.8%	10.1%	9.2%

2.2 Waste generation assumptions

Blue Environment modelled:

- a 'business as usual' option based on historic waste generation, landfill compaction or filling rates (670 kg waste per cubic metre of landfill airspace), and expected population growth
- a 'low waste' option based on reductions in waste to landfill through greater resource recovery of materials, as well and improvement in the landfill filling rate (800kg of waste per cubic metre of landfill airspace).

Assumed landfilled waste generation from different sources of waste are shown in Tables 3 and 4. In August 2016, a survey of the landfill found remaining airspace capacity of 201,650 cubic metres. At the current filling rate of 670kg per cubic metre, this would allow for 135,100 tonnes of waste. At a more efficient filling rate (800 kg per cubic metre achieved through less use of daily cover and greater compaction), the site would have capacity for 161,300 tonnes.

Table 3 shows the business as usual filling option under which the landfill would be filled by 2021. Table 4 shows the low waste option would see the site filled by 2024.

Both waste generation options have been modelled.

2.3 Landfill costs

Landfill costings used in the model are based on:

- cost estimates in the Anglesea landfill development, closure and rehabilitation masterplan
- cost estimates in SCSC's capital expenditure budget for landfill cell development
- current site operation costs
- independent costings of landfill liner, capping and post-closure management requirements.

2.4 Transport, transfer and disposal costs

Transport costs used in modelling are based on:

- Costs estimates of kerbside putrescible waste collection vehicles on a $ per tonne per kilometre basis. This is based on assumed average load sizes of seven tonnes, running costs of $75 per hour, and an average long haul speed on 80 km per hour. This results in a cost of $0.13 per tonne per kilometre.
- Transfer station development costs of $3 million amortised over 20 years.
- Transfer costs based on loading and unloading times at transfer stations and landfills of 20 minutes per load.
- Cost estimates of bulk haul transport based on average loads of 18 tonnes, running costs of $130 per hour and average long haul speeds of 80 km per hour, resulting in a cost estimate of $0.09 per tonne per kilometre.

Disposal costs to alternative landfill have been based on stated prices or other market information about gate fees charged by landfills, inclusive of levies. It is possible the operators of these landfills will offer more competitive prices were they to bid under a future expression of interest process.

The landfills considered were:

- Anglesea landfill

- Calleja, Bacchus Marsh (inert)
- Drysdale landfill
- Fyansford landfill (inert)
- Naroghid landfill
- Ravenhall landfill
- Statewide, Stawell-Ararat
- Stonehaven (proposed)
- Werribee landfill

The Stonehaven site is proposed for development and undergoing planning and environmental approvals process. It is not currently scheduled in the current draft Grampians Central West Waste and Resource Recovery Regional Implementation Plan (GCWWRRIP), and planning and environmental approvals cannot be granted to unscheduled facilities. The future of this site, which is the closest alternative to SCSC, is therefore uncertain. It could not be approved until the site is scheduled, and the GCWWRRIP is not due to be reviewed for 3-5 years.

The modelling assumed that on closure of the Anglesea landfill (in 2018, 2021 or 2024 depending on whether the final stages of the landfill are developed and the rates of filling), inert waste will go to the most cost-effective landfill (Fyansford) and putrescible waste will go to either existing putrescible landfills (modelled as being Ravenhall as the likely cheapest landfill for transport and gate fees) or, Stonehaven if it is developed for post 2021 or 2024 closure of Anglesea landfill. Stonehaven is not considered an option under the 2018 closure option because it will not be established and operating by then. A potential benefit of continuing to operate Anglesea landfill is that there will be greater certainty about the availability of Stonehaven when Anglesea closed in 2021-2024.

The estimated cost of using alternative landfills, inclusive of transfer, transport and gate fees and landfill levy are:

- Putrescible disposed to most cost-competitive landfill (Ravenhall)= $133-135 per tonne from Anglesea landfill transfer station and $131-133/tonnes from a future transfer facility located an estimated 10km closer to the alternative site than the Anglesea landfill. Potential sites for a bulk haul transfer station in this proximity have been identified.
- Inert disposed at Fyansford or Calleja landfill = $106-116/tonne from the Anglesea landfill transfer station.

Transport costs from different townships have also been factored in.

It is assumed that post-closure a small vehicle transfer station will continue to operate at the Anglesea landfill transfer station, but there will be need to establish a bulk haul facility to consolidate loads of kerbside garbage and compactor-vehicle collected commercial waste.

An assessment of transfer and transport options suggest that bulk haul consolidation of loads will be needed to cost-effectively use alternative landfills, with the possible exception of Stonehaven if it is established.

Table 3: Assumed landfilled waste generation – business as usual

Waste source	Year								
	2017	2018	2019	2020	2021	2022	2023	2024	2025
Kerbside garbage – Torquay/Anglesea area & surrounds	4,540	4,670	4,800	4,940	5,090	5,210	5,340	5,470	5,610
Kerbside garbage – Winchelsea/Dean's Marsh	1,470	1,480	1,500	1,510	1,520	1,540	1,550	1,570	1,580
Kerbside garbage – Lorne	580	580	590	590	600	610	610	620	620
Small vehicle putrescible TS waste – Anglesea	1,130	1,160	1,200	1,230	1,270	1,300	1,330	1,370	1,400
Small vehicle inert TS waste – Anglesea	1,390	1,430	1,470	1,510	1,560	1,590	1,630	1,680	1,720
Putrescible C&I – Anglesea	4,620	4,750	4,890	5,030	5,180	5,300	5,440	5,570	5,710
Inert C&I/C&D – Anglesea	6,150	6,330	6,510	6,700	6,900	7,070	7,240	7,420	7,610
Street sweepings - all to Anglesea LF	740	750	770	790	810	820	840	860	870
TS waste – Winchelsea	230	230	230	230	230	240	240	240	240
TS waste – Lorne	420	430	430	440	440	450	450	450	460
Clean fill[1]	7,570	7,740	7,910	8,090	8,280	8,450	8,620	8,800	8,980
TOTAL	28,840	29,550	30,300	31,060	31,880	32,580	33,290	34,050	34,800
CUMULATIVE '000 tonnes	28.8	58.4	88.7	119.8	151.6	SITE FILLED			

1. It is assumed clean fill is landfilled or used within the void as cover or for internal roads.

Table 4 Assumed landfilled waste with waste reduction and more diversion

Waste source	Year								
	2017	2018	2019	2020	2021	2022	2023	2024	2025
Kerbside garbage – Torquay/Anglesea area & surrounds[1]	4,540	3,178	3,266	3,362	3,464	3,545	3,634	3,722	3,818
Kerbside garbage – Winchelsea/Dean's Marsh[1]	1,470	1,029	1,043	1,050	1,057	1,071	1,078	1,092	1,099
Kerbside garbage – Lorne[1]	580	406	413	413	420	427	427	434	434
Small vehicle putrescible TS waste – Anglesea	1,130	1,160	1,200	1,230	1,270	1,300	1,330	1,370	1,400
Small vehicle inert TS waste – Anglesea	1,390	1,430	1,470	1,510	1,560	1,590	1,630	1,680	1,720
Putrescible C&I – Anglesea	4,620	4,750	4,890	5,030	5,180	5,300	5,440	5,570	5,710
Inert C&I/C&D – Anglesea	6,150	6,330	6,510	6,700	6,900	7,070	7,240	7,420	7,610
Street sweepings - all to Anglesea LF[2]	740	750	770	790	810	820	840	860	870
TS waste – Winchelsea	230	230	230	230	230	240	240	240	240
TS waste – Lorne	420	430	430	440	440	450	450	450	460
Clean fill[3]	7,570	7,740	7,910	8,090	8,280	8,450	8,620	8,800	8,980
TOTAL	21,270	19,693	20,222	20,755	21,331	21,813	22,309	22,838	23,360
CUMULATIVE[4] '000 tonnes	21.3	41.0	61.2	81.9	103.3	125.1	147.4	170.2	SITE FILLED

1. Assumes a 30% reduction in kerbside putrescible waste due to the introduction of a FOGO service
2. Assumes street sweepings will be dried, screened and recovered (not landfilled)
3. Assumes clean fill will not be landfilled
4. Assumed an effective fill rate of 800 kg of waste per cubic metre. This will increase the capacity of the landfill to 161,300 tonnes.

3. Comparison of options

3.1 Cost comparison

Costings of option are summarised in the following tables:

- Table 5 shows expected costs of landfill development, operation, closure and rehabilitation under the business as usual option. This assumes growth in waste with population on a constant waste per capita basis and current landfill filling rates of 670 kg per cubic metre of airspace.
- Table 6 shows expected costs of continued landfilling at Anglesea landfill with a reduction in landfilled waste and more efficient filling rates (800 kg per cubic metre of airspace)
- Table 7 shows expected costs under the early closure option assuming no reduction in waste to landfill.
- Table 8 shows expected costs of early closure with waste reduction and recovery strategies.

The purpose of these costings is for comparative analysis. The modelling allows consideration of how significantly different management practices affect cost-effectiveness.

The tables show annual costings and the average per tonne costs each year including and excluding clean fill. Historically in the order of 7,000 tonnes per year of clean fill material are received at Anglesea landfill. Some of this material is used as cover and for site works, and is ultimately landfilled at the site. This represents about 25% by weight of total waste under a 'business as usual' option. In other options modelled (see Tables 6,7 and 8), cleanfill would not be landfilled. Under Option 2: 'Full expansion of the site but with waste reduction and improved filling rates' and early closure options (Options 3 and 4) it is assumed clean fill would be diverted from landfill. Not including clean fill can make the per tonnage costs of management look higher even though overall costs will be lower. This is because fixed costs such as landfill capping, rehabilitation, post-closure management and transfer station infrastructure costs do not change even if the tonnage of waste managed is lower. Dividing these fixed costs by a small tonnage of waste (i.e. without the clean fill) has the effect of increasing per tonnage costs.

The Fox-Lane report considered an option of operating the landfill as an inert site and shipping all putrescible wastes to an alternative site or sites. This option has not been considered in this report because:

- the modelling suggests transporting putrescible wastes to alternative landfills is not likely to be cheaper than continued operation of the site
- considerable investment has already been made at the Anglesea landfill in installing the piggyback liner, and earlier closure will not greatly reduce the areas requiring final capping and rehabilitation.

Cost estimates shown in Tables 5 to 8 also show average costs per tonne and net present value (NPV) estimates for the different options until closure and rehabilitation and through to closure, rehabilitation plus 30 years of post-closure management. In all options, the costs of using alternative landfills after landfill closure are considered. These tables can also be used as preliminary costed 'financial plans' for options. The time horizons selected for comparison are:

- 2017-2027: This period incorporates site closure and rehabilitation for all options, and after this time annual and per tonne costs will be similar under all options as waste will be transported to the alternative landfill(s).
- 2017-2053: This period incorporates post-closure management costs for 30 or so years after closure.

Table 5 Option 1 - Business as usual waste generation and filling option

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Cell development	$1,215,000	$0	$1,152,700	$0	$0	$0	$0	$0	$0	$0	$0
Capping	$2,700,000	$0	$0	$0	$0	$50,000	$5,000,000	$0	$0	$0	$0
Staffing and equipment contract costs	$430,920	$442,124	$453,619	$465,413	$0	$0	$0	$0	$0	$0	$0
Ancillary[1]	$151,671	$151,671	$151,671	$151,671	$0	$0	$0	$0	$0	$0	$0
Site infrastructure (annualised)	$0	$0	$3,007	$4,383	$4,383	$0	$0	$0	$0	$0	$0
Post closure monitoring and management	$0	$0	$0	$0	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000
Post closure waste disposal	$0	$0	$0	$0	$2,934,405	$3,000,895	$3,066,850	$3,137,929	$3,208,896	$3,285,507	$3,355,599
Landfill levy	$919,948	$967,103	$1,017,432	$1,070,069	$0	$0	$0	$0	$0	$0	$0
Bulk haul transfer station depreciation (for off-site after closure) over 20 years	$0	$0	$0	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128
Total	$5,417,539	$1,560,898	$2,778,430	$1,937,664	$3,229,916	$3,342,023	$8,357,978	$3,429,057	$3,500,024	$3,576,635	$3,646,728
$/tonne (including clean fill)[2]	$188	$53	$92	$62							
$/tonne (excluding clean fill)					$137	$139	$339	$136	$136	$135	$135

1. *Ancillary costs include EPA audits and monitoring, and maintenance of access roads and the site.*
2. *Historically in the order of 7,000 tonnes of clean fill material is received at Anglesea landfill. Some of this material is used as cover and for site works and is ultimately landfilled at the site. This represents about 25% by weight of total waste under a 'business as usual' option. In other options modelled (see Tables 6,7 and 8), clean fill would not be landfilled. Under Option 2: 'Full expansion of the site but with waste reduction and improved filling rates' and early closure options (Options 3 and 4) it is assumed clean fill would be diverted from landfill. In the following tables, the estimated per tonne costs including and excluding clean fill is shown. The excluding clean fill is the expected estimated cost of managing wastes under these options.*

Average cost ($/tonne) to closure	$99
Average cost ($/tonne) to 2053	$133
Average cost ($/tonne) to 2027	$141
NPV until 2053	$64,550,654
NPV until 2027	$30,004,916

Table 6 Option 2 - Full expansion of the site but with waste reduction and improved filling rates

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Cell development	$1,215,000	$0	$1,152,700	$0	$0	$0	$0	$0	$0	$0	$0
Capping	$2,700,000	$0	$0	$0	$0	$0	$0	$0	$50,000	$5,000,000	$0
Staffing and equipment contract costs	$430,920	$442,124	$453,619	$465,413	$477,514	$489,929	$502,668	$515,737	$0	$0	$0
Ancillary[1]	$151,671	$151,671	$151,671	$151,671	$151,671	$151,671	$151,671	$151,671	$0	$0	$0
Site infrastructure (annualised)	$0	$0	$3,007	$4,383	$4,383	$4,383	$4,383	$4,383	$0	$0	$0
Post closure monitoring and management	$0	$0	$0	$0	$0	$0	$0	$0	$45,000	$45,000	$45,000
Post closure waste disposal	$0	$0	$0	$0	$0	$0	$0	$0	$2,842,905	$2,911,533	$2,974,081
Landfill levy	$678,478	$644,507	$679,039	$715,030	$753,982	$791,087	$830,089	$871,881	$0	$0	$0
Bulk haul transfer station depreciation (for off-site after closure) over 20 years	$0	$0	$0	$0	$0	$0	$0	$0	$246,128	$246,128	$246,128
Total	$5,176,069	$1,238,301	$2,440,037	$1,336,498	$1,387,550	$1,437,070	$1,488,811	$1,543,672	$3,184,033	$8,202,661	$3,265,210
$/tonne (includes clean fill receival, but is not landfilled)[2]	$179	$45	$87	$46	$47	$47	$48	$49			
$/tonne (excluding clean fill)									$136	$343	$134

1. *Ancillary costs include EPA audits and monitoring, and maintenance of access roads and the site.*
2. *Under Option 2 it is assumed clean fill will be diverted from landfill, conserving airspace and extending the life of the landfill. If material is still received at site and used for final rehabilitation, then the 'including clean fill' per tonne cost can be considered to be the cost of managing the material. If it is not received on site, then the 'excluding clean fill' per tonne costs represents the cost of management.*

Average cost ($/tonne) until closure	$69
Average cost ($/tonne) to 2053	$122
Average cost ($/tonne) to 2027	$106
NPV until 2053	$53,367,671
NPV until 2027	$22,184,502

Table 7 Earlier closure, with waste currently disposed to Anglesea landfill other than clean fill going to alternative disposal sites

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Cell development	$1,215,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capping	$2,700,000	$50,000	$3,816,121	$0	$0	$0	$0	$0	$0	$0	$0
Staffing and equipment contract costs	$430,920	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Ancillary[1]	$151,671	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Site infrastructure (annualised)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Post closure monitoring and management	$0	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000
Post closure waste disposal	$0	$2,714,754	$2,786,121	$2,857,087	$2,934,405	$3,000,895	$3,066,850	$3,137,929	$3,208,896	$3,285,507	$3,355,599
Landfill levy	$919,948	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bulk haul transfer station depreciation (for off-site after closure) over 20 years	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128
Total	$5,663,667	$3,055,883	$6,893,370	$3,148,215	$3,225,533	$3,292,023	$3,357,978	$3,429,057	$3,500,024	$3,576,635	$3,646,728
$/tonne (clean fill excluded)[2]	$266	$140	$308	$137	$137	$136	$136	$136	$136	$135	$135

1. *Ancillary costs include EPA audits and monitoring, and maintenance of access roads and the site.*
2. *Under Option 3, it is assumed clean fill will not be manage through the bulk haul transfer station, and large vehicle loads of clean fill will go directly to alternative landfills or recovery option. Under Option 3, the 'excluding clean fill' per tonne costs represent the expected costs to SCS of managing waste.*

Average cost ($/tonne) to 2053	$139
Average cost ($/tonne) to 2027	$164
NPV until 2053	$66,839,346
NPV until 2027	$32,570,177

Table 8 Early closure with waste reduction and increased resource recovery.

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Cell development	$1,215,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Capping	$2,700,000	$50,000	$3,816,121	$0	$0	$0	$0	$0	$0	$0	$0
Staffing and equipment contract costs	$430,920	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Ancillary[1]	$151,671	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Site infrastructure (annualised)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Post closure monitoring and management	$0	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000	$45,000
Post closure waste disposal	$0	$2,378,088	$2,441,451	$2,504,890	$2,573,712	$2,632,700	$2,691,629	$2,754,705	$2,818,144	$2,886,251	$2,948,306
Landfill levy	$678,478	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bulk haul transfer station depreciation (for off-site after closure) over 20 years	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128	$246,128
Total	$5,422,197	$2,719,216	$6,548,700	$2,796,018	$2,864,840	$2,923,828	$2,982,757	$3,045,833	$3,109,272	$3,177,379	$3,239,434
$/tonne (excluding clean fill)[2]	$255	$138	$324	$135	$134	$134	$134	$133	$133	$133	$133

1. *Ancillary costs include EPA audits and monitoring, and maintenance of access roads and the site.*
2. *Under Option 3, it is assumed clean fill will not be manage through the bulk haul transfer station, and large vehicle loads of clean fill will go directly to alternative landfills or recovery option. Under Option 3, the 'excluding clean fill' per tonne costs represent the expected costs to SCS of managing waste.*

Average cost ($/tonne) to 2053	$136
Average cost ($/tonne) to 2027	$162
NPV until 2053	$60,042,949
NPV until 2027	$29,671,546

The most relevant figures are those for the 2017-2027 period because this is when the most significant differences in waste management occur between the options. After 2027, the costs for all options are similar because management practice will be similar.

This assessment suggests:

- Disposal of waste to alternative landfill sites is likely to be more expensive than the cost of continuing to operate Anglesea landfill.
- The least-cost option is the continued operation of the landfill until remaining capacity is full (option2, Table 6), with reduction in waste to landfill through greater diversion, as well as a higher landfill fill rate. This is estimated to cost an average of $106 per tonne over the next 10 years, and with a lower NPV of $22.2 million.
- Business as usual filling (Option 1, Table 5) is estimated to be more cost-competitive that earlier closure options, with an estimated average cost of $141 per tonne and an NPV of $30.0 million over the next ten years.
- Early closure with FOGO and diversion of cleanfill (Option 4, Table 8) is expected to have an average cost of $162/tonne to 2027 with a NPV of $29.7 million.
- The more expensive option is estimated to be earlier closure of the landfill (in 2018) without any diversion of waste from landfill (Option 3, Table 7). This is estimated to have an average cost of $164 per tonne excluding clean fill and have an NPV of $32.6 million over the next ten years.

It should be noted that the 'low waste' options will have lower overall costs, but can have higher per tonne costs because fixed costs common to all management options are divided by fewer tonnes.

Other benefits of continuing to operate Anglesea landfill until existing capacity is filled are:

- SCSC is less exposed to unexpectedly high increases in waste transport and landfill gate fees. Any such increases will make alternative landfills even less cost-competitive with Anglesea landfill.
- Extending the life of the landfill until 2021-24 may allow time for the proposed Stonehaven landfill to be developed. Depending on the competitiveness of the gate fee charged, this may be the cheapest post-closure option. Depending on transport efficiencies, the proximity of this site may exclude the need for a bulk haul transfer station. However, our modelling suggests a bulk haul transfer operation will still be cost-competitive with direct delivery by collection vehicles, and this is likely to remain the case as innovation in bulk haul vehicles is likely to result in these becoming more efficient over time.
- Early closure of the landfill would require additional master planning and EPA approvals of revised final contours. This has not been costed out model, but would add to the costs of early closure.

Options for diverting waste from landfill need to be further investigated. Suggested methods include:

- Continue to promote and expand existing resource recovery, with effective community engagement and pricing incentives to promote greater source separation of loads for resource recovery. SCSC already use pricing incentives to promote source separation of loads, and could potentially introduce higher gate fees for unseparated loads with high recyclable content.
- Diversion of clean fill, C&D rubble and masonry, timber, metals and commingled and cardboard/paper recyclables, at transfer stations and resource recovery centres.

- Diversion of food and garden organics via a Food Organics and Garden Organics (FOGO) collection service. In the North East of Victoria, councils have reported 30-40% reductions in household waste through the provision of FOGO services and promotion of kerbside recycling services.
- Diversion of street sweeping waste for drying, cleaning and reuse. This material may be suitable for use in rehabilitating the site.
- Consideration of a trial of 'drop and sort' resource recovery for inert small vehicle household and commercial and industrial waste. This could involve loads containing high volumes of recyclable materials being dropped in an area and sorted by staff to recover recyclable materials. Drop and sort resource recovery is expensive because it is labour intensive and has higher occupational health and safety management requirements. The cost effectiveness will depend on the labour costs and value of extracted materials and may not be viable at a small scale. In-coming unsorted loads that contain a high proportion of recyclables could be charged a premium to pay for the sorting and provide additional incentive to waste generators to separate loads for resource recovery. A trial is suggested to determine net costs that could be used to set gate fees for the separation of mixed loads with high recyclable content.

It is also recommended the effective landfill fill rate is monitored and improved through greater use of alternative temporary cover and increased landfill compaction if possible.

3.2 Risk assessment

Financial risks

Financial risks associated with early closure of the Anglesea landfill include:

- Commercial and financial risks of waste transport and landfill gate fees increasing significantly above consumer price index (CPI). Transport costs are to an extent linked to fuel prices and greater than CPI increases in transport fuel can increases costs. Landfill gate fees charged by alternative sites could increase within the next 10 years, as closure of some landfills in Melbourne's south east increases demand and reduces competition for landfills in Melbourne's west.
- Regulatory risk/costs associated with developing a new landfill masterplan for Anglesea and gaining EPA approvals for final contour and rehabilitation of the site. In addition to cost of developing new plans and managing the approval process, there is risk EPA may place additional requirements on the site. The 'void' that would be created if the final stages of the landfill are not developed would need to be managed to prevent pooling of stormwater that could percolate into landfill.
- Loss of investment already made in development of the piggyback liner.
- Early closure will not avoid most of the costs associated with rehabilitation and post-closure management of the site. Early closure of the landfill will only partially reduce the need for final liner and rehabilitation because the piggyback liner area overlies historically landfilled materials. It will not avoid the need for gas mitigation and upgrade of the leachate management system.
- If the landfill closes early, rehabilitation and post-closure management costs, as well as the costs of developing a new bulk haul transfer station will be brought forward, without opportunity to recoup costs from commercial users through landfill gate fees. This will effectively put these costs onto rate payers either through a direct increase in rates for capital works or through an addition to the waste management service charge.

Potentially an increase in kerbside collection costs if collection vehicles needed to travel longer distances than at present in order to get to a bulk haul transfer station. This would particularly become an issue if additional trucks or drivers were needed to complete collection runs due to increased travel times. For the purposes of modelling, it has been assumed the bulk haul facility would be located at a similar or shorter distance as the current landfill is from the main Torquay population centre, but with a location to the north west of Torquay. Increased kerbside collection costs are only likely to be incurred of collection vehicles directly transport waste to disposal sites, but the modelling suggest bulk haul transfer of wastes will be required.

Environmental risks and outcomes

The main environmental benefit of diverting waste from the Anglesea landfill would be the potential for landfill gas energy recover at a larger landfill such as Ravenhall or Wyndham. The extent of this benefit is uncertain because Anglesea landfill is required by EPA to have a landfill gas capture and oxidisation system, and annual audits to demonstrate low rates of gas emissions above the cap. The requirements by EPA for low methane detection levels at landfills means Anglesea landfill need to achieve about 60-70% landfill gas capture and oxidisation. Larger landfills with gas recovery systems can recover higher levels of gas capture (up to 80% or more) after closure and also recover 'renewable' energy from captured gas. Such landfills can be considered to be 'greenhouse neutral' because the emissions from fossil fuel power avoided by landfill gas energy may be equal or higher than fugitive emissions from the landfill. Gas emissions from Anglesea landfill are likely to be 20-40% higher than could be achieved if SCSC wastes went to a larger landfill, and will be about 0.4-0.8 tonnes CO_2-equivalents per tonne of putrescible waste landfilled.

There will be similar pollution risks for options with similar amounts of waste being landfilled. Anglesea landfill is required by EPA to have a best practice liner and capping similar to any other receiving putrescible landfill, so pollution risks will be similar. The new cell will meet EPA Best Practice Environmental Management (BPEM) requirements and have levels of environmental engineering superior to what has been required historically. This means waste deposited in the new cell poses less risk than waste landfilled historically, and early closure will not greatly reduce environmental risks associated with the site. The levels of engineering required for the new cell mean the site will have levels of environmental risk comparable to alternative landfills.

Greenhouse gas emissions from transport of waste are small compared to emissions from landfill and have not been considered in the estimates.

The best way to avoid greenhouse gas emissions from landfill is to reduce the amounts of putrescible waste deposited. Most food and wet garden waste will degrade within five years after landfilling, which means much of the methane generated can be emitted before effective gas recovery systems are in place. The presence of 'wet' food and garden organics in landfill also creates conditions that promote degradation of other high carbon materials such woody garden waste, timber, paper, cardboard and natural fibre textiles. This increases greenhouse gas generation prior to gas recovery systems being installed. Degradation of organics in landfill also generate leachate and the formation of toxic organic compounds such as bioavailable heavy metal organic compounds. Options that promote waste reduction and diversion will have higher environmental outcomes and are recommended as the preferred approach.

Social outcomes

Possible social impacts of early closure of the Anglesea landfill are:

- Reduced heavy traffic to the site. However, equivalent heavy traffic would be directed onto roads leading to the bulk haul transfer station, and very large loads of consolidated waste would be transported greater distances to alternative disposal sites. Overall, loads would be

transported over greater distances with inherent risks associated with traffic safety, damage to roads and localised pollution.

- Increased waste disposal costs for residents and commercial users of the transfer station. Comparative analysis suggests transport and disposal of wastes to alternative landfills will increases costs by in the order of $30 per tonne. This represents a cost increase of 30%. On a per household basis, such cost increases are not expected to be high (less than $15 per household per year for kerbside garbage). However, collectively and for local businesses using the transfer station higher waste disposal costs would have flow- on local economic effect reducing spending and investment in other sectors of the economy.
- Reduced risk of odour and litter from the site in surrounding bushland. This land is current zoned as either Special Use (associated with the former Anglesea coal mine and power station) or Public Conservation and Resource, and does not have high social use. The risk of odour is therefore low. Litter is managed at the landfill although there is risk of some windblown litter.

Early closure of the site will not significantly reduce environmental risks or greatly reduce rehabilitation and post-closure management costs. The cost assessment suggests there is no financial advantage in early closure.

4. Conclusions and recommendations

The modelling suggests the most cost effective option is to continue to operate the Anglesea landfill until remaining capacity is filled, but also reduce waste to landfill where possible.

Earlier closure of the landfill is expected to result in higher costs to the community over the next ten years.

Table 7 showing the estimated costing of the preferred option for continued operation of Anglesea landfill with waste reduction can be used as a preliminary financial plan for the implementation of this option.

Key stages in achieving this include:

- Increasing diversion at Anglesea and other resource recovery centres of clean fill, demolition masonry and rubble, timber and garden organics, metals, and household recyclables.
- Consideration may be given to trailing a 'drop and sort' system for recovery of materials from inert household and commercial and industrial wastes, but the preference is for greater source separation by those using the facilities. Effective community engagement and education is recommended.
- Introduce a regular (fortnightly or weekly) FOGO collection service. This could reduce household landfilled waste by 30-40% by weight.

The expected cost of the preferred option is estimated at an average of $106 per tonne and an NPV of $22.2 million over the next ten years for landfill management, closure and rehabilitation, and then transport and disposal of wastes from residents.

Early closure options are expected to cost around $162-164 per tonne excluding clean fill with an NPV of $29.7-32.6 million over the next ten years.

The findings of a triple bottom line assessment of the risks and outcomes of different options are shown in Table 9. This suggests there is a net financial benefit in keeping the landfill operating compared to early closure. The preferred option of keeping the landfill operating and diverting more organics and other recoverable materials will result in the highest financial, environmental and social benefits.

Table 9 Summary of triple bottom line assessment .

Option	Risks , impacts and outcomes	Comment
Option 1: Business as ususal landfilling at Anglesea.	**Financial** • Estimated costs of $141 per tonne with an NPV of 30.0 million between 2017 and 2027. • Capital costs of cell development. • Slighlty higher rehabiliation costs. **Environmental** • Greenhouse gas and leachate emissions risks from the final cell development at Anglesea. High levels of environmental engineering are required for the final cell and risk and impacts will be similar to at alternative landfills. • Alternative landfills with landfill gas energy recovery will have lower net greenhouse emissions due to off-sets of fossil fuel power. **Social** • Little change from current situation. • Odour and litter risks from Anglesea landfill (this is a low risk as there is little social use of surrounding land)	The assessment suggests keeping the landfill open will have lower costs than early closure. Business as usual filling has lower environmental outcomes than Option 2.
Option 2:Anglesea landfill remains open, with greater diversion of waste and improved filling efficiencies.	**Financial** • Estimated costs of $106 per tonne, with an NPV of $22.2 million between 2017 and 2027. • Capital works at the landfill for the development of the final cell. • Site rehabiltiation costs will be similar under all options. • There may be some additional net costs associated with introduction of a FOGO service if the cost per tonne of having organic processed is higher than at present. If organics processing costs are smilar to current costs, diversion of food will result in cost savings. **Environmental** • Reduced risks associated with organics in landfill (rduce greeenhouse gas, less leachate) • Reduced envrionmental impacts associated with recycling compared to manufacture from first use materials • Soil fertility enhancement from compost products. **Social** • Similar to Option 1 with reduced odour risk due to organics diversion.	Prefered option due to lower costs and high environmental outcomes.
Option 3: Early landfill	**Financial** • Estimated costs of $164 per tonne, with an NPV of	Least preferred option due to higher costs and lower TBL

Option	Risks , impacts and outcomes	Comment
closure with all waste currently landfilled sent to alternative landfill.	$32.6 million over the first 10 years. • Avoided cell development costs, and some reduction in capping and rehabiliation costs. • Costs of developing a bulk haul transfer station and rehabiliation will be brought forward. • Higher transport costs. **Environmental** • Potential for landfill gas energy recovery at alternative landfills will reduce net greenhouse gas emissions. • Other environmental risks are similar regardless of whether Anglesea or an alternatuive landfill is used. • More heavy traffic between SCS and the alternatve landfill. **Social** • Highest waste disposal costs will have negative flow on effects within te local economy. • Redcued heavy traffic on access roads to the Anglesea landfill. • Increased heavy traffic between SCS and the alternative landfill. • Reduced odour and litter risk from the Anglease landfill.	advantages.
Option 4: Early landfill closure with greater diversion reducing waste sent to alternative landfill.	Financial • Estimated costs of $162 per tonne, with an NPV of $29.7 million over the next ten years. Environmental • Similar to Option 2, but with the potential for landfill gas energy recovery and increased heavy traffic from SCS to alternative landfill. Social • Similar to Option 3.	This option is not preferred compared to Options 1 and 2, but is superior to Option 3 due to lower costs and higher environmentla performance.