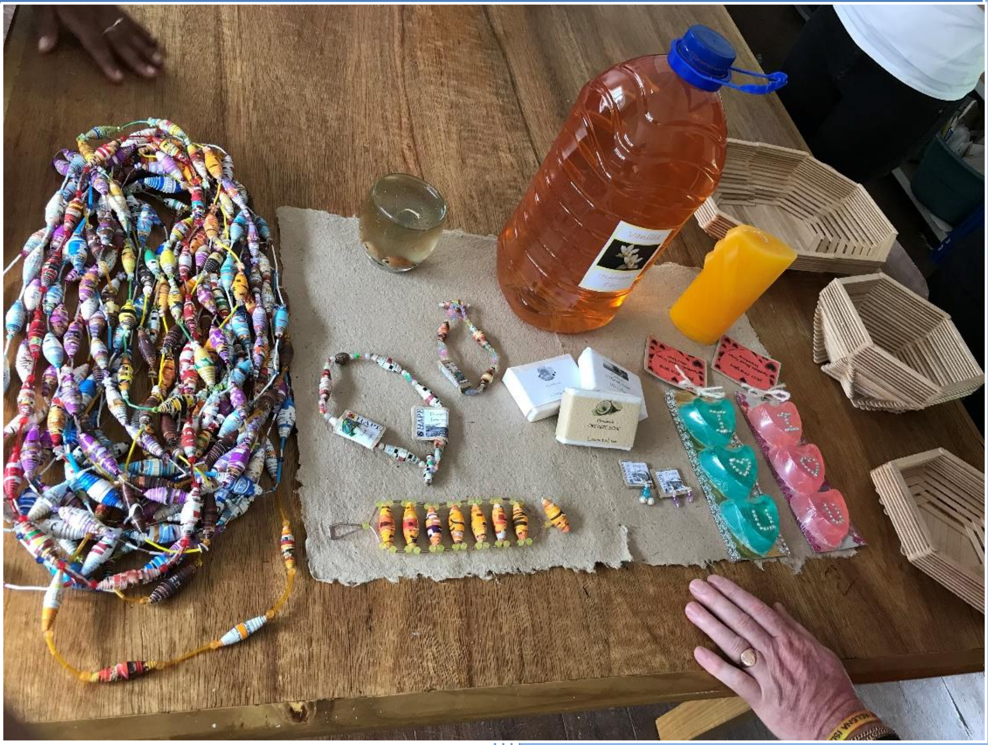
South Atlantic Natural Capital Assessment: St Helena Cost Benefit Analysis, waste management



Alistair McVittie, Mike Durnford, Nicholas Conner, Amanda Gregory, Vicky Morgan, Ness Smith.

April 2019

Review table

Name	Reviewed by	Date
Version 1	Ness Smith	01/05/2019
Version 2	Mike Durnford, SHG	05/05/2019
Version 3	Tara Pelembe and Paul Brickle	17/05/2019
Version 4		

Acknowledgements:

Particular thanks go to the St Helena Advisory Group and Mike Durnford, Environmental Risk Manager for St Helena Government, independent consultant Nicholas Conner and Amanda Gregory and Vicky Morgan from JNCC for their significant contributions to this work. This research was funded by The UK Government via the Conflict, Security and Stability Fund.

Citation:

McVittie, A., Durnford, M., Conner, N. Gregory, A., Morgan, V. and Smith, N. (2019) South Atlantic Natural Capital Assessment: St Helena Cost Benefit Analysis, waste management, Final Report for the South Atlantic Overseas Territories Natural Capital Assessment

For more information, please contact the South Atlantic Environmental Research Institute (SAERI) at info@saeri.ac.fk or visit http://south-atlantic-research.org
PO Box 609, Stanley Cottage Stanley
FIQQ 1ZZ
Falkland Islands
Tel: +500 27374
www.south-atlantic-research.org

1. Background

This study was commissioned by the South Atlantic Environmental Research Institute (SAERI) to assess waste management options for St Helena. The findings contribute evidence to a programme of natural capital assessment (NCA) being implemented by the UK Joint Nature Conservation Committee (JNCC) and conducted by the South Atlantic Environmental Research Institute (SAERI) in the UK South Atlantic Overseas Territories. Funded by the Foreign and Commonwealth Office (FCO) managed Conflict, Stability and Security Fund (CSSF), the work sits under its Environmental Resilience programme which includes objectives to integrate natural capital considerations into economic and social development planning.

A consultation workshop held on St Helena in January 2018, followed by a smaller Advisory Group meeting, resulted in priority areas being identified by on-island key stakeholders for further study. One particular issue identified by residents was the need to find a realistic and affordable means of managing the St. Helena solid waste stream, given predicted increases in tourist numbers following the commencement of flights from Johannesburg to Jamestown are expected to lead to more waste being generated.

Introduction

Economic assessment approaches can be used to evaluate the viability of different actions that may address St. Helena's waste management issues. Cost-benefit analysis (CBA) is one form of economic assessment that can be used to estimate changes to the economic wellbeing of local and wider communities in response to different management approaches.

CBA involves estimating and comparing the costs and benefits of implementing a proposed project or management activity, with the costs and benefits of a 'base case', which represents a continuation of current conditions under which the proposed project/ policy is not implemented. In the case of a CBA for waste management options, the Base Case would represent a continuation of the current approach to waste collection, treatment and disposal (i.e. a 'business as usual' situation). The costs and benefits of alternative management options are then compared with the costs and benefits of the Base Case to identify any incremental differences between the base case and the alternative approaches.

A simple cost benefit analysis for a project will usually consider the direct costs and benefits of a range of options which are likely to achieve a common objective, such as construction, maintenance and administration costs, and revenue received. Costs and benefits over the life of a project are discounted to today's value and subtracted to give a net present value (NPV) and a benefit cost ratio (BCR). Options with a positive net present value and a benefit cost ratio greater than one are considered feasible, with the option with the highest positive NPV and BCR being the most preferred.

Ideally, government projects involving public expenditure should demonstrate that the expenditure incurred provide a net economic benefit to the community. In these cases, a more comprehensive assessment (social cost-benefit analysis) should be carried out to consider the potential impacts of the options in question the wider community, or large parts of the community, and that the proposed activity represents the most economically efficient course of action. The basic concepts underpinning Social CBA come from a branch of economics known as 'welfare economics' which is concerned with the effect of making particular choices about how scarce resources such as time, labour and money can be allocated to increase the economic wellbeing of individuals and groups. These parties in aggregate can be defined as 'the community'. CBA is not concerned with the interactions that occur in the local, state or national economy between the different sectors of the economy (firms, households, government and financial institutions).

Social CBA (hereafter CBA) includes estimates of the indirect costs and benefits of proposed options, as well as the direct costs and benefits. Indirect costs ('negative externalities') occur when the full costs of an action are not borne by the main beneficiaries, but are imposed on a third party, e.g. a polluting industry is reducing its costs of operation by not paying for adequate pollution control of its emissions, but imposing costs on downstream communities which have to pay medical costs for treatment of the effects of this pollution on their health. In this case the polluting industry is transferring a cost it should pay itself to a third party as a negative externality. Indirect benefits ('positive externalities') occur when third parties gain a benefit which they did not pay for, e.g. when renovation of one house in a street leads to an improvement of visual amenity, which increases the perceived market value of surrounding properties.

It is often difficult for economists to estimate the monetary value of the indirect costs and benefits associated with proposed options (as well as in some cases, the direct benefits and direct costs). In such cases, it is acceptable to at least describe the impacts qualitatively, so that decision makers can be better informed about the range of impacts that a proposed option may cause, if implemented

A CBA should also be accompanied by a distributional analysis, which considers how the direct and indirect costs and benefits of preferred options are distributed among different sections of the community. Although a particular option may have the highest NPV and benefit: cost ratio for the range of options being considered, particular groups may disproportionally benefit, or bear costs. For example, a particular option may produce high private benefits, but also high public costs for the community, yet still have a positive NPV and benefit cost ratio. It is important that decision makers are aware of the distributional aspects of the costs and benefits of a project, as they may wish to take compensatory actions to mitigate some of the negative effects on specific groups, while continuing to implement a preferred option which has a high NPV and BCR (and thus provides an economic benefit to the community overall).

This report describes a CBA that has been carried out to identify appropriate waste management options using a CBA framework, and to assess the direct costs and benefits of a range of alternative options compared to a status quo Base Case (i.e. 'Business as Usual'). The report then ranks these options according to their ratio of benefits to costs and their net present value (i.e. the difference between the estimated costs and benefits of the options over the project's life, expressed in today's prices).

It is important to note that the Base Case is not the same as a 'do nothing' approach, as government agencies are already carrying out various management activities to address the issue of concern. A 'do nothing' approach would involve agencies ceasing all existing management activities, and so does not represent a continuation of the status quo, and does not represent an appropriate Base Case.

The waste management options described below provide direct benefits to certain parties (such as prevention of diseases associated with inadequate putrescible waste management), and may impose costs on other parties e.g. the government agency paying for the project. However, other groups who do not receive direct benefit or pay the above direct costs, may also be affected positively or negatively by the options. In the case of this project, it has not been possible to estimate the value for indirect costs and benefits, and so these have been expressed in qualitative terms, rather than quantitatively. Further, it has also not been possible to estimate the direct benefits of the options considered in monetary terms, and again, these have been described in qualitative terms.

It should be noted that CBA does not generally consider how the options being assessed may be funded or financed. These issues should be considered once a preferred option has been identified.

The following sections of the report describe the current waste management system, and a range of feasible options that may be able to address St. Helena's waste management issues, including continuing with current approach (i.e. the Base Case).

Waste disposal in St. Helena – the current situation

At the present rate of waste disposal, the current landfill at Horse Point will have a life of approximately ten more years before it will be full[1]. However, expected increases in visitor numbers related to the flights to St. Helena, and increased consumption associated with increasing standards of living, are expected to increase volumes of waste needing disposal (EMD, 2017). EMD (2015) refers to an earlier strategy report by Jacobs Gibb (2003) that suggests the increased waste from tourists is estimated to be the equivalent of that produced by 50 additional full-time residents[2].

It is not possible to easily extend Horse Point Landfill Site (HPLS) beyond current boundaries because it is in close proximity to several National Conservation Areas. The availability of areas for extending the HPLS is also limited because past waste disposal practices used land within the site inefficiently compared to today's more efficient compacting methods. Once the capacity of the site has been reached, a new landfill site will need to be found and developed at a different location.

Ideally, a new landfill site should be relocated away from residential properties to reduce the negative impacts of noise, odour, dust etc., and at least 13km from the airport to reduce strike from scavenging birds. However, no such alternative site with these features exists on the St. Helena. The development and operation of a new landfill on whatever (sub-optional) site is chosen, will bring a range of social and technical risks not currently found at HPLS. For example, a potential site at Donkey Plain will involve the need to construct a new highway for access, and expensive and challenging ground-works to excavate the surface rock.

Given the shortage of suitable sites, additional short-term and longer-term solutions are needed to defer the need for a new landfill site, while managing St. Helena's waste to prevent public health and environmental concerns.

---

[1] Personal communications with Mike Durnford, SHG Head of Risk Management.

[2] The increase in tourists numbers assumed by Jacobs Gibb (2003) is unknown. However, in 2018 there were 2367 arrivals on St Helena for tourism (1247 were non St Helenian). If each tourist stayed for an average of 1 week that would suggest the equivalent of 46 additional full-time residents. (Visitor data from http://www.sainthelena.gov.sh/wp-content/uploads/2019/05/Population02052019.xlsx)

2. Proposed options

Suitable options will be those that enable waste management to be achieved in the near future, and provide a net economic benefit to the community; .i.e. where the sum of the stream of discounted direct and indirect benefits is greater than the sum of the discounted direct and indirect costs of the project over its life, and is positive. The ratio of these benefits to these costs should be greater than one

It has not been possible to provide monetary values for the likely range of direct and indirect costs of the following options for businesses, government and the community. Instead, this assessment only quantifies the monetary values for the direct costs of the options where they are available, and describes their likely indirect costs and direct and indirect benefits.

This combination of quantitative and qualitative assessment enables a comparison to be made between the proposed options and the continuation of status quo as represented by the Base Case (Option 1).

The options proposed to address St. Helena's waste management issues are discussed below.

Option 1: Base Case; Business as Usual

This option is based on a continuation of current practices over the CBA timeframe of 25 years. Activities involve a landfill at HPLS, plus some waste separation, and some redevelopment of the facility at a cost of £1.5 million (EMD, 2015), most of which is assumed to occur from Year 5 to Year 15.[3]

Some public education is also planned to attempt to reduce volumes of waste going to the facility. It is hoped that these measures will defer the need for the large-scale capital expenditure and environmental impacts associated with Option 2, a new landfill, until the end of the project period at Year 25.

The 2015 Waste Management and Recycling Options Assessment suggests that the current location of HPLS is culturally acceptable (EMD, 2015). When HPLS is full, it is likely that the new landfill will be sited in a more populated, and quite probably less acceptable, area.

While some reuse and recycling and public education is planned under the Base Case, this will be far less well-organised and comprehensive (and effective) than would occur under the dedicated programmes proposed under Option 4. Arguably, the life of HPLS under the Base Case will be shorter than if a comprehensive reuse and recycling programme were in place, and will bring forward the date when a new landfill site needs to be developed, with its associated infrastructure expenditure. The opportunity costs of this expenditure for St Helena Government (SHG) should be borne in mind

Risks and opportunities

The Base Case involves the continued operation and maintenance of HPLS into the future. This option avoids the negative externalities that would come with a new landfill in a more populated area. However, with expected growth in waste disposal, and without a comprehensive programme to

[3] The Water security CBAs considered in another document used a 25-year time-frame for infrastructure works projects. A 25-year time frame was also considered appropriate for this assessment.

reduce waste going to landfill, this option will not be able to defer the need for a new landfill site beyond an estimated ten years.

Option 2: A New landfill site at Donkey Plain

This option considers the excavation and development of a new waste landfill at Donkey Plain and closure and restoration of the existing facility at Horse Point once it is full in about ten years under current estimates. Although Donkey Plain has been historically identified as a potential site for a new landfill, EMD (2015) notes that it has not be adopted as such and is only used as a model to develop indicative costs. Further, constraints mapping of new landfill sites by Marengo et al. (2018) did not identify Donkey Plain within the suitable areas (see Appendix 1).

Establishing a new site at Donkey Plain would require expensive planning, infrastructure and environmental controls. The Donkey Plain site would require construction of a new highway to avoid current access via a private quarry, and expensive groundwork to excavate suitable cells for landfill.

Indicative costs for the landfill are given in Appendix 2, based on the replacement or transfer of all facilities to a new 10 Ha site in Donkey Plain and using recent figures for the upgrade of HPLS (EMD, 2015). Costs include an options appraisal, land purchase, fencing, services, relocation of mobile plant, construction and commissioning of a new landfill suitable for airport safeguarding. The relative proximity of houses would also require development and management of infrastructure to mitigate the effect of methane emissions from the landfill. A replacement landfill site at Donkey Plain could cost around £2.7million when all airport safeguarding infrastructure has been taken into account.

Donkey Plain is closer to residential properties than Horse Point and would be expected to create more negative externalities for residents from noise, vehicle and plant movement, dust, odour (including landfill gas), vermin etc. The new landfill could also potentially reduce local house values, compared to a continuation of the situation under the Base Case, although it is important to note that very few houses are bought and sold currently.

Risks and opportunities

A new landfill will provide a waste disposal facility for St. Helena for the forseeable future, and provide some reassurance to the SHG and residents that waste was being managed safely and hygienically, with no risk to public health. However, the lack of suitable sites in St. Helena at a distance from residential development, means that there are likely to be more negative externalities from a new site at Donkey Plain that at the present site at Horse Point. As with the base case, waste management strategies based on landfill are not sustainable in locations where there is a shortage of land areas to fill.

Option 3: An incinerator

The 2017 report 'Developing a Waste Management Strategy for Ascension Island' provides some information that would be relevant to the option of building and operating a waste incinerator on St. Helena.

According to the Ascension Island report, the main advantage of incineration is that it is a simple way to greatly reduce the volume of waste going to landfill. Although incineration waste residues will still need to be landfilled, the landfill will not require landfill gas or leachate management, as the residues will be inert. The 2017 report notes that all waste can be added to an incinerator, although it may be advantageous to exclude food waste, as its moisture content reduces the calorific value of the waste and the combustion efficiency of the incinerator, which could lead to increased fuel consumption for the burners.

The key disadvantage with incinerators is the emission of pollutants from the stack. Emissions principally comprise CO^2, N^2O, NOx, NH^3, organic C, CO, HCl, SO^2, VOCs and particulates.[4] The Ascension Island report suggests that a wet scrubber could be installed to improve emissions, however these emissions would still not comply with the European Union Industrial Emissions Directive (IED). Technologies such as waste heat boilers, sodium bicarbonate, activated carbon and urea injection would need to be used to comply with IED.

Besides significantly adding to capital costs, pollution abatement will also add to the cost and complexity of operations. The Ascension Island strategy notes that the monitoring equipment alone required for IED compliance could cost around £200,000, and that in total the cost would be 'several multiples of the cost of the incinerator itself'. (Generalised costs for a small-scale incinerator (assuming no pollution abatement); are £170,000 (excl. taxes and shipping) for used equipment including diesel tank, automated feeder and de-ashing equipment (300 kg/hr unit), compared to costs of £327,000 for new a 300 kg/hr unit.[5] However, accurate costs cannot be estimated until there is a clear understanding of what would be required to manage St. Helena's specific waste management requirements. As well as construction and operational costs, other costs to be considered include the costs of specialist training for operators, and decommissioning costs at the end of the incinerator's useful life.

This option may impose social costs on members of the community, depending on the location of the incinerator. Costs may include health impacts from pollution, and noise and visual disturbance from waste vehicle movements and construction and operation.

The incinerator proposed under this option may be constructed by external contractors, but operated by the public utility. However, the incinerator could be constructed under a Build-Own-Operate-Transfer (BOOT) scheme. Decisions about ownership, operation and maintenance will need to be made by St Helena Government.

Risks and opportunities

Although an incinerator would provide many advantages for St. Helena's waste management issues, including considerably extending the life of the HPLS, the high costs of the pollution abatement equipment needed to comply with the EU IED would need to be taken into account.

A detailed review of incinerator technologies would need to be carried out under this option, including identifying the potential for energy recovery and emission abatement technology, and obtaining costings from a range of different suppliers.

---

[4] Carbon dioxide, Nitrous Oxide, Nitrogen Oxides, Ammonia, organic Carbon, Carbon monoxide. Hydrogen chloride, Sulphur dioxide, volatile organic compounds.

[5] The strategy mentions that a second supplier quoted c. £69,000 for a 200 kg/hr unit, plus £21,000 for a ram loader and £35,000 for automated ash removal. It is not known whether these figures are for used or new equipment. As an exercise, if it was assumed that these figures are for used equipment, and excluding taxes and shipping, and were pro-rated to 300kg/hr, they would give a figure of ~£188,000 for this package of work.

Option 4: Reuse, Composting and Recycling

This option is a combination of activities which will encourage reuse of materials that can still be used for their original, or new purposes, recycling of parts and materials for different uses, and composting of green waste for landscaping and gardening.

The St. Helena Waste Management and Recycling Options Assessment report (2015) provides a detailed assessment of the scope for reusing, recycling and composting different categories of the waste stream, using different levels of processing. Materials can be sorted and processed for on-island use, or exported as raw material for sale in Africa for recycling.

Items suitable for export include paper, cardboard, steel and aluminium cans and rigid plastic. Smaller, very valuable, fractions, such as copper, may also be collected. However, export sale prices would need to at least cover staff costs to sort waste, capital expenditure for plant to process and package the material, and in the short-term, annual operational costs to freight material overseas. Main recycling opportunities, as set out in EMD (2015), are described below; all costs are provided at equipment cost and exclude import and shipping costs.

Glass

Glass recycling on-island would require investment in a glass imploder, at approximately £30K-£40K. Collecting and sorting glass could be carried out as part of normal waste management activities. Recycled glass is valued at £3,500 per annum and would increase with the volume of glass recycled, which would depend on the degree of resources put into publicity, education and collection. Crushed glass could be added to road sub-base or block-work for house construction.

Cans and tins

There are no on-island buyers of aluminium and steel cans but if sorted, compacted and baled, this material can be exported. Steel currently generates £83 per bale (UK rates), whilst aluminium generates £557 per bale. It is expected that the amount of steel currently imported to St. Helena (in the form of drink cans) will drop significantly in the near future, and the amount of aluminium will rise, as the major drink can packer exporting to St. Helena replaces steel cans with aluminium cans. A compactor/ baler will be needed to process aluminium cans, at a cost of £8K-£10K. Based on current shipping costs, current aluminium value, and an expected 50% of current steel tins becoming aluminium, an estimated £15K might be generated per annum after processing and shipping costs.

Paper and cardboard

Over 70 tonnes of paper and cardboard waste is produced annually on St. Helena, excluding direct commercial disposal. Ninety to 97% of paper and cardboard waste goes to landfill. There are very few opportunities for using recycled paper and card on St. Helena, with the main market being SHAPE, which currently uses 3% of this waste for artisan craft products. It is unlikely that SHAPE would use more than 10% of the paper and card waste even if it increased its capacity to produce craft products.

Processed paper and cardboard can be mixed with kitchen waste to generate compost. This process would require a chipper and bio-digester (which can also be used for kitchen waste) and staff resources to separate and treat the material prior to composting.

A separate compactor and baler would be required to process cardboard and paper for overseas recycling. Costs for this equipment are between £8K-£10K, excluding shipping and duty. Although the revenue from exporting paper and cardboard would be less than the current cost of shipping (£14K per annum), there would be benefits from diverting this material away from landfill, and so slowing the rate at which HPLS fills up. A short-term alternative to recycling could be shredding and incineration (see Option 3).

Plastic

Rigid plastic in the form of Polyethylene terephthalate (PET) (i.e. most rigid plastic waste) and High-density polyethylene (HDPE) can be compacted and baled for export and overseas recycling. Alternatively, it can be chipped before landfilling to reduce volume. A chipper would cost from £15K-£20K. Chipping PET and HDPE may reduce landfill volume but does not reduce waste production, or provide any source of material for reuse or repurposing.

Textiles

St. Helena produces at least 25 tonnes of textile waste a year. If separated from the rest of the waste stream, this material can be used as second-hand clothing, incorporated into SHAPE products, or sold as rags.

Polystyrene

The St. Helena Waste Management and Recycling Options Assessment report argues that a significant reduction of polystyrene packaging is needed if St. Helena is to credibly market itself as a green tourist destination. Methods for reducing waste include levies on polystyrene packaging, replacement with alternative packing materials, and education campaigns to change public behaviour. A large part of managing this waste stream involves providing information and incentives to consumers to reduce use of these materials. The waste strategy suggests that, if the private sector is unable or unwilling to use alternative packing materials, it may be necessary for SHG to impose higher charges that will have a stronger influence on consumer behaviour, or ban import of products using polystyrene.

Hazardous waste

The existing HPLS accepts_waste oil, waste fuel (aviation, diesel, petrol), vehicle batteries, waste electronic and electrical equipment, which is stored or buried in the hazardous waste cell at the landfill site. This waste is potentially recyclable if exported to approved facilities overseas. However, under the Basel convention, countries exporting waste are required to have a formal agreement with waste processing importers. St. Helena does not have such agreements, and urgently needs to make suitable agreements with, for example the UK, Namibia or South Africa, for exporting waste.

End of life vehicles

End of life vehicles are currently compacted, and buried. This option includes the establishment of a vehicle scrap yard which may be commercially viable.

Composting

Some 130 tonnes of kitchen waste went to landfill in 2013. This organic waste could be converted into a useful, relatively low value compost for use on-island. It would be necessary to remove edible food from this waste before composting to avoid it attracting birds. Removing kitchen waste from landfill, and thus its attractiveness for birds, is a potentially effective way of reducing birdstrike at the airport (exclusion netting is currently used for this purpose).

Biodegradable kitchen waste is the main source of landfill gas generation. At present, the rural location of HPLS means that there is little impact on surrounding properties from methane emissions from the landfill. Removing putrescible household waste from the waste stream for composting would help to reduce the need for landfill gas infrastructure mentioned in Option 2.

There is a substantial market for mulch and compost from works being carried out under the Landscape Ecological Mitigation Plan (LEMP). Secondary markets include landfill restoration, EMD conservation and the St. Helena National Trust, as well as public and agricultural consumers. The LEMP will require £11K (import cost) of compost and mulch in the next five years (2015 figures). The LEMP alone would easily consume all the organic waste currently generated on-island if it were composted and mulched. A suitable bio-digester would cost in the region of £14K plus shipping and import costs. The practicalities of kitchen waste collection and digestion would need further investigation under this option.

Garden or green waste

Although households do not produce much green waste, it is created in quantity by the SHG Roads Section, with private contractors disposing of this waste to the landfill as general bulky waste. A chipper (£15K-£20K) could be used to convert this material into mulch or compost.

Mulch is not imported into St. Helena because of biosecurity risks, and is not produced on-island in quantity; however compost is imported. Composted green waste could be sold for landscaping and restoration at the Airport, and to the private sector and general public to off-set the costs of the operation, so reducing the volumes going to landfill and reducing the need to for imported compost.

Risks and opportunities

Option 4 proposes an active reuse, recycling, and composting option, which will support economic development by facilitating the development of new products or income streams, and reduction of waste to landfill.

The waste strategy notes that once land is lost to landfilling, it ceases to be a multifunctional piece of land, and becomes unsuitable for a wide range of other purposes. Given the significant constraints on the supply of land on St. Helena, it is important that multi-functionality is maintained wherever possible. Recycling very strongly supports multi-functionality.

Diverting waste into more constructive uses under this option could reduce imports, and consequently the large carbon footprint associated with shipping. It also would reduce the additional packaging waste that comes with imported goods. If recyclables can be used in place of virgin material, they will be less carbon expensive, and can preserve the multi-functionality of the land where the virgin materials were extracted.

Removing various waste streams from landfill by reuse, recycling and composting, will help to defer the need to find capital expenditure to restore HPLS, and to develop a new landfill at Donkey Plain (Option 2). Such postponement would save the £2.7M otherwise needed to develop a suitable new landfill site.

Option 4 also has other benefits from prolonging the life of HPLS, including delaying the negative externalities for local residents from nuisance from noise, lorry movement, dust, odour, vermin etc. and reduced house values associated with a new landfill at Donkey Plain under Option 2.

3. Cost-benefit assessment

In this section we present the analysis of available costs and benefits for each of the options. These will be based on the available data either from St Helena or from appropriate cases elsewhere. However, the analysis does remain partial across each of the options. Each of options is evaluated using a range of discount rates: 4%, 7% and 10%. Where there are differential flows of costs and benefits over time, the use of discounting allows those flows to be expressed in present value terms. The higher the discount rate the lower the value placed on flows that occur further into the future. This reflects both the concept of time preference where immediate returns are preferred, but can also account for future uncertainty. The use of multiple discount rates can test the robustness of the CBA.

Option 1: Business as usual

The available data for the BAU option is restricted to the costs of limited expansion of the HPLS. These are assumed to be £1.5 million spread over 10 years from year 5 of the analysis. We assume that this cost is incurred equally in each of those 10 years, i.e. £150,000 per annum. There were no future benefits identified for this option. Table 1 summarises the present value of those costs at the different discount rates used for the analysis. The table illustrates the considerable effect that choice of discount rate has on the present value of costs. It has been suggested that the increased volumes of waste generation on St Helena, due to increased consumption and higher tourist numbers may mean that the BAU actions will be needed sooner. This would have the effect of increasing the present value of the estimated costs.

Table 1 Present value costs of business as usual

	Discount rate		
	4%	7%	10%
Business as usual	£1,039,984	£803,739	£629,523

Option 2: A new landfill site at Donkey Plain

Detailed cost estimates of the potential new landfill site at Donkey Plain have been produced, these are summarised in Table 2. These reflect upfront site preparation and costs rather than ongoing operational costs. Although the incidence may not be immediate they are sufficiently close to the start of the lifetime for discounting to be unnecessary. However, they are not directly comparable with the option 1 as the costs for BAU do not consider the landfill set up costs already incurred, just the additional costs to provide expanded capacity.

Importantly, the new landfill costs do not include the higher social costs expected in comparison to BAU. These arise due to proximity to settlements and would include increased disturbance from traffic and noise. Odour, dust and vermin are further impacts associated with proximity to landfill. These additional costs could be observed through reduced property values, although robust estimation would be difficult given the relatively small population of St Helena. A study for Defra in the UK by Cambridge Econometrics, eftec and WRc (2003) evaluated the impact of proximity to landfill sites on residential property values. Across Great Britain, being within 0.25 miles of a landfill reduced property values by an average of 7%, this declined to a 2% fall between 0.25 and 0.5 miles, with no negative impacts found at larger distances. However, there was considerable variation across different regions, so a robust estimate of the potential impact on St Helena might not be possible.

Table 2 Summary costs of new landfill site

Item	Cost (£)
Planning and engineering designs and approvals	114,000
Site preparation	741,731
Access roads	330,000
Buildings and facilities	655,193
Land acquisition (market price reflects opportunity cost)/siting	679,250
Total	2,520,174

Option 3: An incinerator

A more detailed analysis of the costs and benefits of an incinerator is possible as we can identify some potential benefits, namely the reduced cost of the lower volumes of waste going to landfill. Each m^3 of landfill space (void space) that is not utilised is valued at £1.95 (EMD, 2015). By estimating the reduction in the volume of waste going to landfill under incineration, it is possible to determine the potential benefits of this option.

We assume that the quantity and composition of waste remains as reported in EMD (2015). The diversion of waste from landfill to an incinerator would include paper, card, rigid plastic and green waste[6]. Glass and metals would continue to be landfilled. We do not have an estimate of the volume of incinerator residue that would be sent to landfill. Based on EMD (2015) calculations for potential recycling the annual volume and value of landfill void space for the waste fractions going to an incinerator are as summarised in Table 3.

Table 3 Volume and value of landfill void space from waste fractions that can be incinerated (source: EMD, 2015)

	Void space saved (m^3)	Value of void space (£)
Paper	42	82
Cardboard	56	109
Rigid plastic	447	871
Green waste [a]	107	208

[a] The volume of green waste was estimated using conversion factor of 0.75 m^3/tonne (https://www.sustainabilityexchange.ac.uk/conversion_factors_for_calculation_of_weight_to_vo)

The costs of the incinerator option arise from the purchase of the incinerator plant, pollution abatement and monitoring to ensure compliance with the Industrial Emissions Directive, and the diesel fuel costs. We assume that waste collection costs are the same as under the landfill options, although waste may need to be separated into combustible and non-combustible fractions.

We consider two options for incinerator purchase, either a new or used, these are estimated at £327,000 and £170,000 respectively. IED compliance would costs a further £200,000. For fuel costs, we assume a burn rate of 300kg/hour which would require 25 to 30 litres of diesel/hour[7]. Given the volume of combustible waste (285 tonnes) this suggests a running time of 950 hours, which multiplied

[6] Green waste includes kitchen waster (130 tonnes/annum) and garden waste (12 tonnes/annum)

[7] https://www.inciner8.com/general-incinerator/I8-250G

by the mean fuel consumption (275 litres/hour) gives an annual fuel consumption of 26,125 litres. The cost of fuel is estimated as £0.94/litre[8], giving an annual fuel cost of £24,558.

The present values of the costs and benefits of the new and used incinerator options are summarised in Table 4. The results of the CBA show that the costs greatly exceed benefits. However, the comparison with the initial establishment costs of set up a new landfill suggests that for each incinerator option and discount rate, the incinerator option would be a cheaper option.

Table 4 Present value and benefit/cost ratios of incinerator options

Present value	Discount rate		
	4%	7%	10%
Benefits (£)	19,840	14,800	11,528
Costs (£)			
Used incinerator	753,647	656,189	592,914
New incinerator	910,647	813,189	749,914
Net present value (£)			
Used incinerator	-733,807	-641,389	-581,386
New incinerator	-890,807	-798,389	-738,386
Benefit-cost ratio			
Used incinerator	0.03	0.02	0.02
New incinerator	0.02	0.02	0.02

Option 4: Reuse, Composting and Recycling

The final option involves the reuse, composting or recycling of different waste streams as appropriate. Glass would be processed for reuse on St. Helena as an aggregate material in construction and road maintenance. The associated benefits would be the avoided costs of imported aggregate materials. Green waste would be composted (garden waste) or processed through an anaerobic digester (kitchen waste) to produce compost, the benefit would be the reduced import of compost materials. Paper, card, metal tins and plastic would be baled and transported off St. Helena for recycling, the benefits being the potential market values for these materials. There would also be benefits in each case due to the value of the landfill void space. The associated costs would include the machinery required for the processing of the different waste streams and the shipping costs for the export of recyclables.

Table 5 presents the direct and indirect benefits of reuse, composting or recycling different waste materials. Glass can either be processed to produce 'sand' for construction or coarser cullet for road maintenance, this will affect the value of the material. Plastic can both be baled and exported for recycling or it can be chipped and landfilled. Baling and recycling will have the indirect benefit of landfill void space. Chipping will reduce the space taken up by plastics in landfill in comparison to unprocessed waste, but we do not have figures for the size of this decrease. These different benefits allow us to calculate two scenarios – the highest benefit where glass is used for cullet and plastic is baled and recycled, and a lower benefit where glass is use for sand and plastic is chipped and landfilled. The annual benefits of these scenarios are £75,932 and £72,456 indicating that there is little difference.

[8] We assume diesel can be purchased at wholesale price of 75% of £1.25/litre retail price.

Table 5 Direct and indirect benefits of reuse, composting and recycling options

Waste stream		Annual benefit (£)
Direct Benefits		(£)
Glass reuse	Cullet (substitution)	3,060
	Sand (substitution)	2,870
Cans/tins recycling	Steel (revenue)	4,316
	Aluminium (revenue)	33,420
Paper/card recycling	Paper (revenue)	1,950
	Card (revenue)	2,460
Plastic	Rigid plastic: HDPE & PET (revenue)	2,415
Green waste	Compost (import cost saving)	2,270
Indirect benefits		
Landfill void space value	Glass	624
	Steel	1,207
	Aluminium	1,207
	Paper	82
	Card	109
	Rigid plastic	871
	Green waste	208
Total	Glass	
	Cullet	3,684
	Sand	3,494
	Cans/tins	50,060
	Paper/card	12,324
	Plastic (baled and recycled)	3,286
	Green waste	6,578
Total benefits		
1. Lowest benefit: glass used for sand, plastic chipped and landfilled		72,456
2. Highest benefit: glass used for cullet, plastic baled and recycled		75,932

The costs of the reuse, composting and recycling option vary across different types of processing machinery. These are outlined in Table 6 which also includes the annual operating costs associated with each option. The table includes the average (mean) cost for equipment where a range was available. Glass reuse machinery ranges in the price from £32,250 for Glassbusters to £55,960 for Krystaline machinery. Operating costs were only available for Glassbusters and cover cutting blades, motor and conveyor, the costs have been annualised based on expected lifespan and waste volume. In the CBA analysis we assume these costs would apply across the different types of glass processing machinery. The type of metal tin compactor and baler also has an impact on cost, a vertical compactor being priced at £9,000 compared to £27,500 for a horizontal compactor. There are two options for plastic, a compactor and baler (associated with the recycling option) is priced at £9,000 whilst a chipper (for landfill) is priced at £17,500.

The difference in price for plastic processing machinery would suggest that plastic should be baled and exported for recycling. However, the volume of plastic produced would require an additional 2.2 shipping containers at £2,995 per container. Although chipping and landfilling plastic has a higher upfront capital cost, it will have lower operating costs due to the avoided shipping costs. Note that 2.2

x £2,995 = £6589 exceeds the combined recycling revenue (£2,415) and landfill void benefits for plastic (£871). However, we do assume that each waste stream requires dedicated machinery, it could be possible to use the same chipping machine for green waste and plastic, or the same compactor/baler for paper, card and plastic.

Table 6 Capital and operating cost estimates for reuse, composting and recycling

Waste Stream		Capital cost (£)	Annual operation cost (£)
Direct Costs plant and machinery			
Glass	Glass imploder (mean)	35,000	
	Glassbusters	32,250	
	Krystaline	55,960	
Cans/tins	Steel/alu compactor/baler (vertical mean)	9,000	
	Steel/alu compactor/baler (horizontal mean)	27,500	
Paper/card	Compactor/baler (mean)	9,000	
Plastic	Chipper (mean)	17,500	
	Compactor/baler (mean)	9,000	
Green waste	Biodigester (kitchen waste)	14,000	
	Chipper (garden waste mean)	17,500	
Direct costs operating			
Glass	Glassbusters (blades)		800
	Glassbusters (motor)		30
	Glassbusters (conveyor mean)		160
Green waste	Hammers		270
Transport (shipping)	All exported waste streams		33,125
	Exc chipped plastic		26,581
Total costs			
Glass	Glass imploder	35,000	990
	Glassbusters	32,250	990
	Krystaline	55,960	990
Cans/tins	Steel/alu compactor/baler (vertical mean)	9,000	
	Steel/alu compactor/baler (horizontal mean)	27,500	
Paper/card		9,000	
Plastic	Chipper	17,500	
	Baler	9,000	
Green waste		31,500	
Transport (shipping)	Inc plastic		33,125
	Exc plastic		26,581
Total costs			
1. Lowest initial cost: Glassbusters, vertical can compactor, plastic baler		59,250	34,115
2. Highest initial cost: Krystaline, horizontal can compactor, plastic chipper		141,460	27,571

As with the benefits we can identify two scenarios based on the highest and lowest cost options. In this case the lowest costs is a Glassbusters glass processor, vertical can compactor and a plastic baler, this has a capital costs of £59,250 and annual operating cost of £34,115. The highest cost scenario is a Krystaline glass processor, a horizontal can compactor and a plastic chipper, the capital cost are considerably higher at £141,460, although operating costs are lower at £27,571 due to not shipping plastic for recycling.

The outcomes of the CBA are summarised in Table 7. For comparability, the lowest benefit scenario is evaluated against the highest cost option as these both involve chipping and landfilling of plastic waste. The highest benefit scenario of plastic recycling is evaluated against the lowest cost scenario. Both scenario comparisons have positive net benefits and benefit-cost ratios in excess of 1. However, it should be noted that 75% of the revenue from recycling (and 63% of total direct benefits) are due to the value of aluminium cans. This waste stream effectively subsidies the other recycling streams, suggesting that a holistic view should be taken with respect to waste management.

Table 7 Present value and benefit/cost ratios of reuse, composting and recycling options

Present values	Discount rate		
	4%	7%	10%
Benefits(£)			
1. Plastic baled and recycled	1,272,122	948,963	739,152
2. Plastic chipped and landfilled	1,131,913	844,372	657,686
Costs (£)			
1. Plastic baled and recycled	592,193	456,808	368,910
2. Plastic chipped and landfilled	572,176	462,761	391,723
Net present value (£)			
1. Plastic baled and recycled	679,929	492,154	370,242
2. Plastic chipped and landfilled	559,737	381,611	265,963
Benefit-cost ratio			
1. Plastic baled and recycled	2.15	2.08	2.00
2. Plastic chipped and landfilled	1.98	1.82	1.68

4. Summary

The preceding analysis used available estimates of costs and benefits for four alternative waste management options. Benefits data were not available for either of the landfill options. These were also not directly comparable as the new landfill option was fully costed, whereas the costs of the BAU option included only the costs of additional capacity at the existing landfill site.

Option 3 to build and incinerator was able to include benefit information in terms of the avoided landfill space. This option did not pass the benefit-cost test on its own merits, but the net costs did compare favourably with the new landfill option.

The reuse, composting and recycling option did have a positive net present value, indicating that this was the best option in economic terms. However, the success of this option relies on reused materials (glass) and compost being acceptable and markets being available for exported recyclables. The viability of the option is particularly reliant on the value of recycled aluminium. This suggest that encouraging substitution of aluminium for other forms of packaging would be beneficial.

We implicitly assume that waste collection costs are the same across each of the options. However, it might be expected that costs will increase as greater levels of separation are required (either before or after collection), the incidence of that cost will depend on the whether separation is by households and businesses or at waste management facilities. The ease of separation may also be an important driver of uptake by households and businesses. In turn, the 'quality' of separated wastes might impact on the marketability and acceptability of reused and recycled products, e.g. whether quality requirements are met.

The analysis has also only focused on the direct and indirect costs and benefits of the waste management operations. Each option may impose further costs on households in proximity to the associated waste facilities, e.g. due to noise, traffic, emissions. The incinerator option will also have higher greenhouse gas emissions due to the use of diesel fuel. The processing machinery used for the other options may be electrically driven offering the potential to use renewable energy (those costs were not included in the analysis).

References

Cambridge Econometrics, eftec and WRc (2003) A study to estimate the disamenity costs of landfill in Great Britain, Final report, Defra London https://webarchive.nationalarchives.gov.uk/20130403044452/http://archive.defra.gov.uk/environment/waste/strategy/legislation/landfill/documents/landfill_disamenity.pdf

EMD (2015) Waste Management and Recycling Options Assessment, Environmental Management Division, St Helena Government, ERM-2015-009

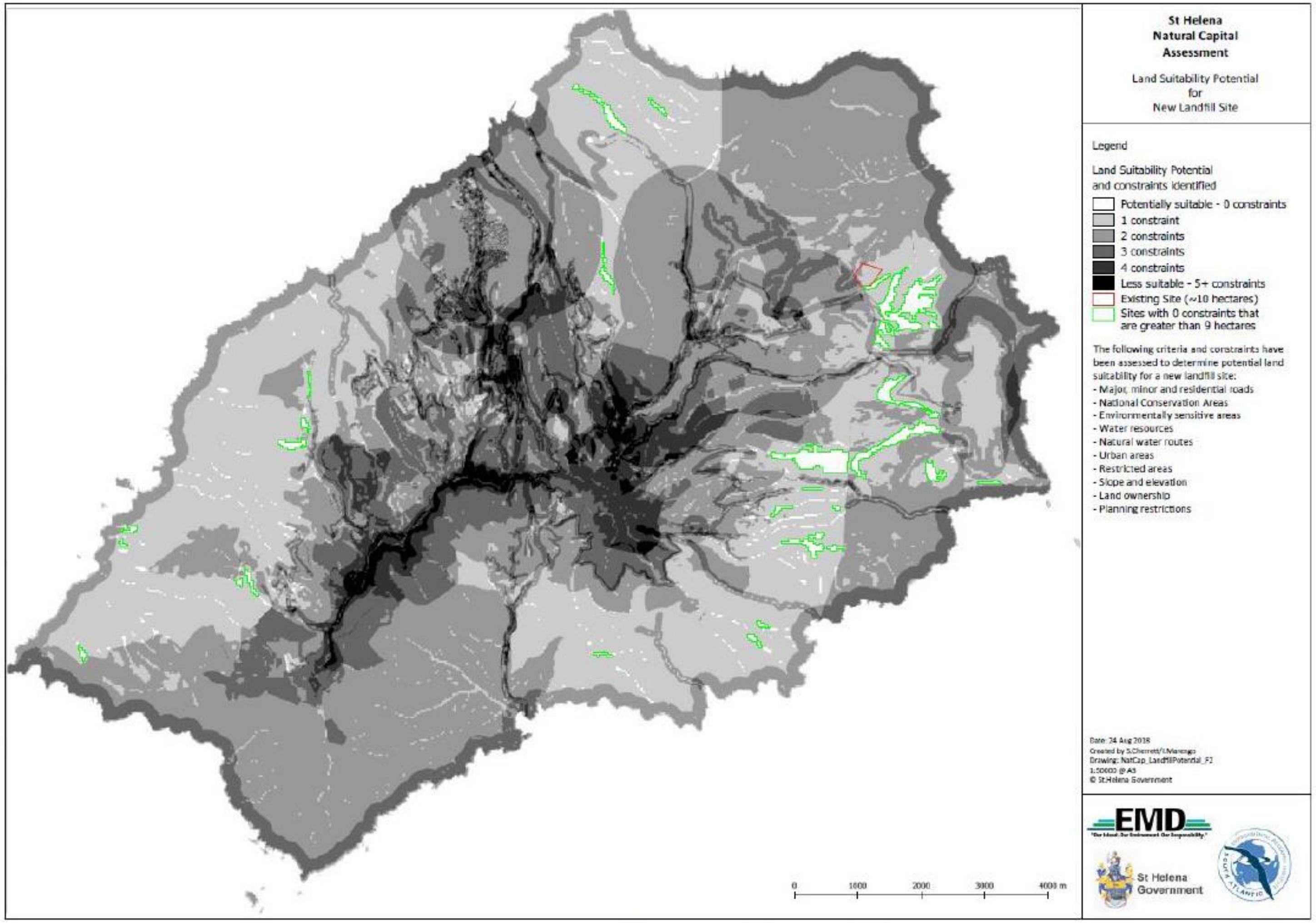
EMD (2017) Waste Management Strategy, Environmental Management Division, St Helena Government

Jacobs Gibb Ltd (2003) – Integrated 30 Year Waste Management Strategy and Action Plan for St Helena.

Marengo, I., Cherrett, S. and Smith, N. (2018) South Atlantic Overseas Territories Natural Capital Assessment: Constraints mapping to identify suitable land-fill sites on St Helena, Final Report for the South Atlantic Overseas Territories Natural Capital Assessment

2017 report 'Developing a Waste Management Strategy for Ascension Island'

APPENDIX 1: Potentially suitable sites for landfills



APPENDIX 2: Estimated costs for new landfill in Donkey Plain

Estimated costs for identification, consultation and construction / transfer of assets to a 10Ha site in Donkey Plain

Item	Rate	Units	Indicative Cost	Reference (date)
Options Appraisal	£40,000	1	£40,000	Estimate
EMD Project Management	£4,000	18	£72,000	Estimate Full time at Head of Waste Management Grade (months) plus junior support
Chief Engineer to oversee construction	£1,666	12	£20,000	Estimate EMD time cost planning EIA & consultation
Two way access road avoiding quarry.	£275	1200	£330,000	(£275/ linear m, total length 1.2km) (B Hathway, road division *pers coms* June 2015) £
Land cost	£27,500	24.7	£679,250	£25-£30,000 per acre for Donkey Plain Area (G Henry, Crown Estates, *pers coms* June 2015). Current site is 10Ha is 24.7 acres
Site clearance	£1.64	10,0000	£164,000	Site clearance BR BoQ 2014
Fencing	£23	1240	£28,520	2m high security fencing, installed. BR BoQ 2014. R
Double leaf gates	£483	3	£1,449	BR BoQ 2014
Internal roads and drainage channels	£100,000	1	£100,000	BR BoQ 2014
Public Recycling Facility	£105,000	1	£105,000	BR BoQ 2014
RCV Waste Reception Building	£520,000	1	£520,000	BR BoQ 2014
Landfill surface preparation	£6.04	67000	£404,680	For area of same size as was currently cleared. Donkey Plain is on rock so taken to be hard rock excavation value.
Waste cell excavation	£6.04	2880	£17,395	Cost per cell excavated into rock.

Item	Rate	Units	Indicative Cost	Reference (date)
Utilities & infrastructure	£3,000	1	£3,000	Estimate based on Landfill upgrade costs
Incinerator compound	£30,193	1	£30,193	Budget sheet 2015
Hazardous waste cell	£22,707	1	£22,707	Budget sheet 2015
Relocation and contingency	£65,000	1	£65,000	Estimate
Planning Application	£800	1	£800	2012-13 Capital Budget