

November 2003



Markham Willows Master-Planning Activity 9, Waste Management Model – Final Report

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***Windrow composting in the
UK***

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Submitted to exSite Research Limited

Executive summary

Introduction

The Markham Willows project is an integral part of the wider Markham Employment Growth Zone (MEGZ) regeneration initiative (320 hectares) which is centred on the site of the former Markham Colliery.

Markham Willows is in itself a large project that will take place on the North and South Tips of the former Markham Colliery. It will initially implement 60 hectares of short rotation coppicing and regular biodegradable matter addition as a means of managing the land, providing beneficial re-use of wastes such as green wastes and sewage sludge and stabilising or containing contaminants in the former colliery spoil heap.

Within the Markham Willows project there are a number of separate but interlinked activities. These are the establishment of Short Rotation Coppice for use as a harvested fuel, the use of biodegradable materials to provide nutrients and humic substances, production of wood fuel for use at the MEGZ development and the opportunity for the creation of a community company to manage and support the project.

This report considers the local realities of waste management in terms of waste procurement, treatment technologies, and use of composts and markets, with an overview of the regulatory status for the project. The position and the involvement of the district authorities, both from the aspect of procuring waste and also from the environmental regulation and governmental requirements that constrain the districts will also be considered. It will be essential that the districts who consider Markham Willows as a partner for the treatment of their waste can do so in complete confidence that they will meet best value guide lines criteria and that the use of Markham Willows stands up to auditable scrutiny.

An important aspect of the Markham Willows project is its approach to the treatment of the colliery spoil surface. Sewage sludge has been traditionally used to provide nutrients for growth promotion in remediation projects. For the Markham Willows project a mixture of sewage sludge and compost will be used for the formation of a new topsoil horizon while leaving the existing spoil heap surface *in situ*. Subsequent applications of compost as a mulch will provide additional organic matter and provide the humic conditions necessary for continued growth of the willow.

Local Waste Management Strategy

UK government waste strategy and the European landfill Directive will require substantial diversion of waste from landfill. This will require the development of appropriate waste handling and recycling facilities. With existing waste contracts in Derbyshire due for renegotiation in 2005, the Markham Willows project offers a useful composting option. Composting at Markham would help to meet one of the strategic aims of the waste strategy and would assist the county in diverting biodegradable waste from landfill. Given the political will, Markham Willows has the potential to expand to become an exemplar project involving sustainable and integrated technologies all beneficial to the overall ethos of the project, sustainability, regeneration and employment.

The 1999 Derbyshire Waste Management Strategy Document committed the county to an integrated waste management strategy, which reflected the requirements of the waste directive and landfill directive. This strategy included the composting of biological wastes. The strategy also reflects the “proximity principle” and the adoption of “best practical environmental option” (BPEO) in the development of its of waste collection and treatment policies.

The Markham Willows project fulfils the proximity principle, as biological waste would need to be sourced from the District Authorities who surround the Markham site. The district authorities of Bolsover, Chesterfield and North East Derbyshire comprise a grouping know as the North East subarea.

In order that the districts, which comprise the North East subarea, could contract with Markham Willows, the facility would need to provide best value, especially in terms of costs and environmental performance. The project team envisioned that this would best be achieved and demonstrated by providing a discounted gate fee below current commercial rates, so that they are able to demonstrate “best value” in a single tender action procurement.

Derbyshire County Council indicated that the North East subarea grouping of district councils could potentially provide some 6,000t per year of green waste sourced from green waste collection schemes and civic amenity sites. Based on the subarea population of 120,000 and figures for typical civic amenity site collection and separate green waste collection, the potential biodegradable waste stream is 20,000 TPA, based on current waste generation rates. While this figure is not based on the highest recorded per household collection rates, for example that could be achieved by including kitchen wastes; it does assume 100% collection, and 100% participation, so a maximum arising may be lower. Hence, while there is some scope for an increasing delivery of green waste to a Markham Willows composting facility, a 10,000 TPA facility seems a sensible compromise.

A suitable site linked with an initial contracted and secure source of compostable waste are the key factors in the development of composting facility at Markham Willows, the green waste will form the corner stone of waste input, with additional suitable compostable green waste sourced locally from private and commercial sources.

Local Waste Arisings

The potential organic wastes, which might be composted and applied to soil formation and SRC cultivation on Markham Willows, include:

- Sewage sludge – not considered as a composting feedstock as it is unlikely that a gate fee could be charged
- Mechanical Biological Treatment residues from mixed waste collection – not considered further due to regulatory concerns on the application of finished composts
- Compost made from source-segregated wastes collected by local authorities including kitchen wastes – not considered at this stage due to increased infrastructure and operational cost needed to meet regulatory requirements for composting of this material
- Compost made from source-segregated wastes collected by local authorities NOT including kitchen wastes, i.e. “green wastes”. This could also encompass Private Sector waste sources such as green waste from commercial landscaping contractors and tree surgeons (Groundwork Creswell 2002)

Only green waste, excluding kitchen wastes, was considered as a suitable feedstock for the initial Markham Willows Composting facility, for the reasons set out below.

Constraints on Waste procurement

Compostable or Biodegradable waste is a significant component of the household waste stream, however it is in most cases contaminated by other waste, which makes it unattractive as a feedstock for composting operations for which the end use may be agriculture, horticulture or virtually any other current use for composts and mulches other than engineering materials for landfill. This source of biodegradable waste is usually separated from household waste by processing the household waste stream through a mechanical biological treatment (MBT) system or by source separation.

Current legislation classifies biodegradable waste in the household waste stream as “Catering Waste” and as such, requires it to be composted to a specific set of conditions that comply with the Animal By-Products Order. This is a statutory order introduced in the wake of the BSE and foot-and-mouth Epidemics. The aim of the order is to prevent the re-occurrence and spread of these diseases by preventing the distribution of pathogens that can be carried in compost that has been improperly stored or processed, and which is subsequently spread on grazing land.

The effect of ABPO is to require composting unit’s to provide facilities appropriate to the materials that are being composted. The result is a two-tier system in which organic wastes which have had no contact with meat or meat products can be composted in a relatively “low tech” and low cost “windrow” only system. All other

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compostable materials require a much higher standard of containment with a more rigorous operating regime with subsequently higher capital and operations costs and generally referred to as “In vessel” composting systems.

Biodegradable waste, which originates from domestic households, can be split into a number of categories as indicated in Table 1.

Table 1 Generic composition of household waste

| Generic Type of waste. | Consisting of | Commercial Scale Treatment Option |
|-------------------------------|--|---|
| Green or garden waste. | Grass clippings, shrubs, weeds, flowers, leafs etc | Turned windrow |
| Kitchen and catering waste. | Vegetable trimmings ¹ , fruit peelings, raw and cooked food waste | In vessel composting system complying with ABPO Regulations |
| Other biodegradable waste | Card, paper, biodegradable packaging, disposable nappies and incontinent pads, miscellaneous biodegradable materials | In vessel composting system complying with ABPO Regulations or preferably incineration. |

A compostable waste, which does not require specialist treatment and which is readily available from householders by a separate collection system, is Green or Garden Waste. This is biodegradable waste from the garden only and does not include kitchen materials, vegetable stalks etc, but does allow bush’s, shrubs& grass cuttings and as such is exempted from the constraints of the animal by products regulations (Defra 2003)

This is the target material for most source separation schemes provided by local authorities across England, Wales and Scotland. Additional sources of green waste may be found within the Private Sector, arising from such business as tree surgeons and garden maintenance contractors, the size of this arising is difficult to estimate.

Compost Production

Cost modelling by AEA suggests that for 6,000 TPA input level, with a discounted gate fee and utilising shared use of equipment and labour, operating costs may be covered by gate fees. However, income would be sensitive to commercial pressures such as fluctuations in waste volumes. A facility would need to process 10,000 TPA or more to be fully commercially viable.

It was essential therefore that that the Markham Willows project identified the most cost effective composting approach, described below.

¹ This material is considered to be likely to be contaminated by meat products and is therefore classified as catering waste unless it can be conclusively proved that no contamination has occurred.

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The Markham Willows facility will be a windrow system, which will consist of triangular piles of shredded green waste, which are regularly turned to stimulate microbiological activity. The operation will be carried out on a large asphalt pad, which will be designed to collect rainwater run off and leachate for reuse in the composting operation. The equipment used for the operations is typical industrial mobile plant such as front-end loaders and telescopic handlers. Shredding equipment will be selected for its ability to be used on MEGZ estate maintenance and be suitable for chipping of SRC and wood to a specification suitable for fuel use.

The nature of the composting operation means that there is a great deal of compatibility in terms of equipment use and labour skills that can be utilised and integrated with other departments such as the Markham Enterprise Growth Zone estate management team. This includes the use of equipment and labour to maintain and support the SRC willow plantations providing long-term all year round sustainable employment, at the lower end of the skills spectrum.

Compost Application

The short rotation coppice plantations would be the main user of the output of the composting facility. It became apparent in the project planning stages that the composting facility is unlikely to be producing finished compost in volume until the end of 2005. However planting of the first plot of willow is planned for the spring of 2004. A need for compost imports of 3,800 to 15,800 tonnes may therefore be necessary, depending on the extent to which compost is used in soil forming work (see below). The figures for imported compost cover the SRC establishment period of 2004-2008 and represent the total requirement that may be needed.

For each 15ha SRC plots there will be an initial period of several months for soil formation and willow planting. A first cutback follows after 12 months. There is a further 20-24 month growth period prior to harvesting giving a 3-year first cycle. After the first harvest, each plot will then be harvested at 3 or 4-yearly intervals.

Both the soil formation and cultivation stages will use compost. The soil formation stage is based on the addition of sewage sludge and compost (pot trials carried out by AEA indicate that the combination is better than using either material alone). Cultivation uses compost as mulch applied after first cutback and after harvest.

Current master planning envisions a total plantation of 60ha, thus leading to the establishment of the first new plot in the spring of 2004 and subsequent planting in the spring of 2005, 06, & 07, i.e. on 15 ha plots.

During soil forming organic matter is applied to the surface to be planted. This is then mixed into the top 15 cm of the surface using a disc cultivator. The maximum depth that can readily be disced in on the surface of the North Tip is 10 cm². It is assumed a 50/50 mixture of sewage sludge and compost is applied, as this will be the simplest mixture to manage on site. To allow some leeway, the application depth to be used is 8 cm, hence the depth of compost added will be 4 cm.

² Coppice Resources Limited, Personal Communication.

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4 cm depth of compost and 4cm depth of sewage sludge will equate to approximately 3,000 tonnes of compost (assuming a bulk density of 500 kg.m³) and 6,000 t of sewage sludge (assuming a bulk density of 1000kg/m³) for each 15ha plot.

Mulching is based on an application of 4 cm depth of compost, which will equate to 3,000 tonnes per application. These depths of composts represent relatively small additions, and greater volumes could be added.

On site compost production at Markham Willows is likely to begin, at the earliest by mid 2005 following the granting of the waste management licence and completion of construction of the facility³. With a process time of 3-4 months, no significant amount of compost is expected from the Markham Willows facility during 2005. Modelling for compost delivery only considers production of a yearly basis and therefore the compost produced from waste input in 2005 is only considered available for use in 2006.

To enable more precise predictions to be made on the relationship between waste input, compost production, compost requirements and the need to import compost, modelling would need to be carried out on a more detailed basis, most probably by looking at the needs and requirements on a quarterly basis. Modelling at this level would also allow seasonal variations in deliveries to be incorporated.

Figure 1 illustrates the production and use of compost at the Markham Willows project over time, based on the following assumptions and projections.

The projection assumes an increase in green waste input over a 4-year period taking the facility up to its full capacity. The increase in waste is assumed to come from household participation in source separation and collection services for green waste and use of the facility by private contractors such as landscape gardeners. Table 2 shows the assumed projection for an increase in input tonnage.

Table 2 Predicted input tonnage for Markham Willows

| Year | 2005 | 2006 | 2007 | 2008 | 2009 |
|---------------|------|-------|-------|-------|--------|
| % Increase | | 10% | 15% | 15% | 15% |
| Input Tonnage | 6000 | 6,600 | 7,950 | 8,728 | 10,037 |

During the composting process, there is an overall mass loss (loss of tonnage), which is the result of moisture loss and biological degradation. A nominal reduction of 30 % is used to demonstrate this effect for modelling purposes, which in actual composting operations can be in the range of 25%-40% dependant on the composting regime, seasonal and atmospheric conditions.

The output or finished compost tonnage is also influenced by the size of the materials screened out of the finished compost. Oversize materials, which in most commercial composting operations means >25mm are rejected reducing the finished mass further. The modelling exercise takes this factor into account, allowing for the use of a greater

³ DCC indicated that this would be their expected timescale for the development.

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amount of oversize, which is considered to be beneficial in the production of compost for mulching applications.

Thus for the input tonnage predicted in Table 2, the model predicts finished compost tonnage will be as shown in Table 3.

Table 3 Comparison of Input and finished compost tonnage

| | | | | | |
|------------------|-------|-------|-------|-------|--------|
| Input tonnage | 6,000 | 6,600 | 7,590 | 8,728 | 10,037 |
| Finished compost | 4,200 | 4,620 | 5,313 | 6,109 | 7,026 |

In practise, there is a significant processing time to be considered which is generally between 3-4 months from delivery of waste to the facility. The input tonnage to finished compost relationship is also affected by seasonal delivery variations and climatic conditions. Therefore the model assumes that finished compost received in year X will be stockpiled for use in Year Y. Table 25 shows the modelled output of finished compost, based on the projected input tonnage

In practice it is likely that compost would be stockpiled until required for use. The SRC plots will be harvested in late autumn or early spring depending on the ground conditions and an application of compost will be made on the completion of harvest. Suitable contractors will most probably carry out the actual application of composts in one operation and this would also require that a sufficient stock of compost is available to ensure a cost effective operation.

Table 4 Modelling predictions of finished compost from the Markham Willows facility

| | | | | | | |
|----------------------------|------|-------|-------|-------|-------|-------|
| Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| Finished compost available | 0 | 4,200 | 4,620 | 5,313 | 6,109 | 7,026 |

Willow planting will therefore require compost to be imported to the site, particularly during the soil forming stages, which coincides with the development, and build up of production of the Markham Willows facility. With the first plot due to begin soil forming operations in the spring of 2004, and the remaining three plots in subsequent years, compost will be required for soil formation and mulching. Table 5 indicates the SRC requirements for compost.

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Table 5 SRC soil formation and mulching requirements for compost⁴

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---------------------|-------|-------|-------|-------|-------|-------|-------|
| Compost requirement | 3,000 | 6,000 | 6,000 | 9,000 | 6,000 | 3,000 | 3,000 |

Table 6 indicates the predicted requirements for imported compost. By cross-referencing with Table 5 and Table 4, the net compost requirement can be derived.⁵

Table 6 Compost import requirements

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|-------------------------------------|-------|-------|-------|-------|-------|-------|-------|
| Compost required (Table 5) | 3,000 | 6,000 | 6,000 | 9,000 | 6,000 | 3,000 | 3,000 |
| Compost available from MW (Table 4) | 0 | 0 | 4,200 | 4,620 | 5,313 | 6,109 | 7,026 |
| Imported | 3000 | 6,000 | 1,800 | 4,380 | 687 | | |
| Surplus | | | | | | 3,110 | 4,026 |

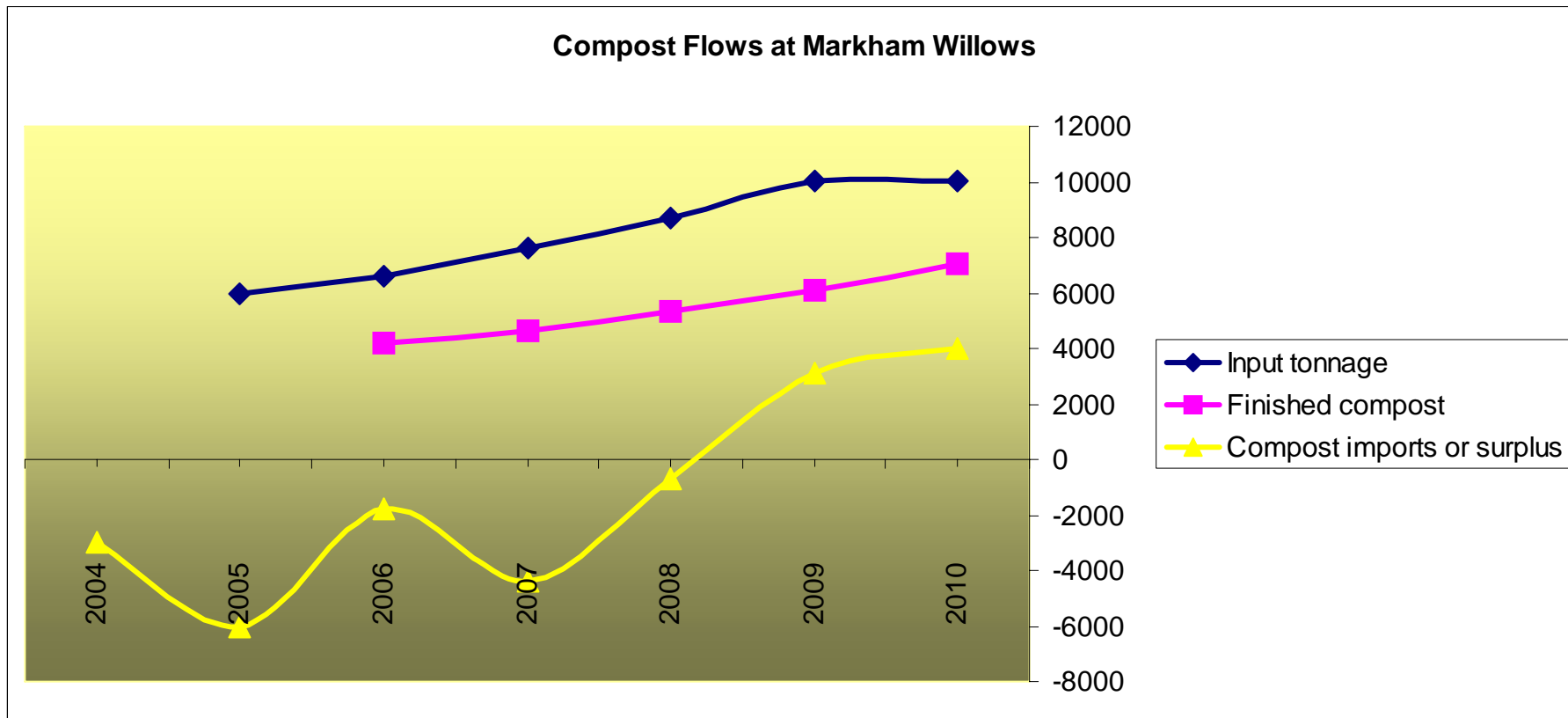
The variations in the requirement to import compost are due to the staggered planting of the 15 ha plots coinciding with cutback and harvesting applications. By 2008 all plots are planted and the requirement for compost reduces to an application to each plot after it has been harvested. The plots will be harvested every 4 years after the initial harvest and a post harvest application of 4cm of compost results in a compost requirement for 3,000tpa.

From 2009 the Markham facility will produce surplus compost, which can be utilised in either deeper applications of compost or will be available for use or sale.

⁴ Predictions are based on year by year modelling; more precise prediction will require a more detailed model.

⁵ The full model can be accessed via R3 Environmental Technology Ltd.

Figure 1 Compost requirements and flow during establishment of the SRC plantation



Note that the values shown represent the total materials required or produced at year-end.

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Following the establishment of the four SRC plots, there is likely to be a surplus of compost available for sale. It is envisioned that these materials would be available to the districts and county for use in ground keeping and estate maintenance activities. Alternative markets for compost were also identified such as the APEX marketing project, which purchases bulk quantities of compost for retail sale.

Usually green waste composting facility's can at least produce compost to the British Standard PAS 100, which would enable widespread use depending on available markets, although compost prices per tonne do tend to be low in monetary terms.

Infrastructure, costs and operations

Costs for both infrastructure and equipment have been defined and developed with incorporation of cost elements into the internal business planning. Cost elements include options for purchase, contract hire and contracting in of services such as shredding and screening, costs for compost testing and civil engineering costs.

Table 7 Main cost elements for Markham Willows.

| Cost centre or element | Description | Cost impact and comment |
|----------------------------------|---|--|
| Site and physical infrastructure | Roads, fencing, hard standing, drains, lagoons, landscaping, weighbridge and office/ mess rooms | Significant initial cost required establishing the facility, with ongoing maintenance |
| Compost processing equipment | Front end loader, shredder, Screen, windrow turner | Many options available from outright purchase to contracting in the services required. Option chosen depends on funding available and green waste input tonnage |
| Operational labour and support | At least two staff allocated | Waste management licence will require COTC ⁶ staff member allocated to site. Costs may be shared across other duties dependant on facility loading |
| Testing and compliance | Testing of compost produced for accreditation of facility | Facility to strive to be an accredited compost producer producing compost to the British standard PAS 100. Will require inspection and regular testing of its output compost |
| Waste Management licence | WML Required to operate the facility. | Initial application fee and ongoing annual charges for compliance |

⁶ Certificate of technical competence issued by WAMITAB

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The design of the infrastructure has been based on a hardwearing asphalt pad of 9,500m² with drainage to a leachate lagoon and circulation system. Onsite buildings would be “Portacabin” type for mess rooms and office. The estimated composting capacity of the hard standing is 10,000tpa and allows for seasonal peaks in the supply of green waste materials

A number of options were identified for the procurement of equipment and contract services for the composting process. The range of options covers the outright purchase of various types of equipment through to the contracting in of services and equipment for use at the facility.

A total of six options were considered which developed a direct cost recovery range of between £5 per ton using a mixture of new and second hand equipment to £14 per ton for all new equipment. Other options looked at contract hire of equipment and contracting in services such as screening. These options produced mid range prices of £6-£10 t based on a 3 year operating period with yearly input of 6000tpa All costs are direct recovery costs and do not include fuel and maintenance costs.

This model indicates that at 6,000tpa input, the facility and equipment would be working at a very low level of efficiency and that additional waste would be required. This is confirmed by cost modelling carried out by AEAt, which suggest that the minimum throughput for the facility should be 10,000tpa.

The final choice of equipment procurement will be critical to the profitability of the facility. The expected level of throughput does not support a case for major equipment spend. In simple terms, green waste inputs below 10,000tpa do not achieve high levels of equipment use and efficiency, which is reflected in a relatively high cost per tonne of throughput.

Confirmation by Derbyshire County Council of the waste available will be required before accurate costs for production can be developed, as there are several significant options that will affect the wider operational cost base, which has been developed and identified by AEAt and R3.

Regulatory and Health & Safety issues

The green waste composting facility requires a waste management licence issued by the Environment Agency. Assuming the site would be the responsibility of Derbyshire County Council, they will be required to provide suitable financial provision and suitable insurances. The waste management licence also requires that a person holding a current Certificate Of Technical Competency issued by WAMITAB be employed at the facility.

Health and safety issues are considered mainly in the context of bio aerosols, noise, dust and odours, but given the location of the proposed facility in the centre of the North Tip, or even at locations nearer to the boundary, the issues are not expected to present a significant problem providing sufficient operational safeguards are taken during procedures such as windrow turning and screening.

Conclusions

The possible supply from Derbyshire waste collection authorities of an estimated 6,000tpa of green waste has provided the composting phase of the Markham Willows project with a base structure from which it can develop. While 6,000tpa of green waste is unlikely to be commercially sustainable, in the long term it will provide the base loading and justification to develop the necessary infrastructure and obtain the regulatory waste management licence necessary to operate a green waste composting operation. With a clear understanding of the facility in terms of capacity, capability and timing, Further feedstock's may be secured from private sector suppliers such as landscape contractors, Securing additional waste will be a key element in taking the facility into commercial sustainability within a reasonable time frame. Potential development routes could be the provision of "in vessel" type systems to deal with more difficult wastes. However this would be totally dependant on availaibility of these compostable materials. The composting facility will provide long-term employment and contribute to Derbyshire's recycling and composting efforts while playing a pivotal role in the Markham Willows project

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1. Overview of the project

1.1 Introduction

The Markham Willows project is an integral part of the wider Markham Employment Growth Zone (MEGZ) regeneration initiative (320 hectares) which is centred on the site of the former Markham Colliery. MEGZ includes redevelopment of the colliery site and other land in the vicinity, which together with improved transport infrastructure including a new motorway junction and upgrading of the principal road (A6192), aims to provide an estimated 5,000 jobs in North Derbyshire.

Markham Willows is in itself a large project that will take place on the North and South Tips of the former Markham Colliery. It will initially implement 60 hectares of short rotation coppicing and regular biodegradable matter addition on the colliery north tip as a means of managing the land, providing beneficial re-use of wastes such as green wastes and sewage sludge and stabilising or containing contaminants in the former colliery spoil heap (Bardos *et al* 2001). Markham Willows has the intention of generating revenue from sales of heat and composting services to provide for the economically sustainable management of the land into the future. Markham Willows also has an important social dimension promoting local area regeneration, community enablement and “green tourism”.

The Markham Willows project forms not only a vital part of the sustainable regeneration of the Markham area, but will also provide a new focus and new identity for a major part of the North Derbyshire / North Nottinghamshire coalfields area through its potential position as an internationally recognised exemplar of environment-led regeneration of major significance. This report is part of the master planning work carried out Derbyshire County Council

1.2 Integration of the Markham willows project within the Derbyshire waste strategy.

The 1999 Derbyshire Waste Management Strategy is the policy statement for the County of Derbyshire. All local authorities in the county contributed to the document (Derbyshire County Council 1999). The Strategy sets out the strategic principles for waste management in the county to 2011. The strategy adopts the key government principles of reduction, reuse, recovery of value from waste and disposal as set out in Waste Strategy 2000 (Waste Strategy 2000)

The strategy also reflects the “proximity principle” and the adoption of “best practical environmental option” (BPEO) in the development of its of waste collection and treatment policies.

The study considers three sub areas. These are the sparsely populated Western sub area, which lies in the park district national park; the North East sub area centred on Chesterfield; and the South East sub area centred on Derby City. While adopting the overarching aims of the Waste Hierarchy, each area may differ somewhat in its approach to waste management techniques and facilities.

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The Markham Willows project itself is located in the North East sub area within approximately 10 miles of Chesterfield, consequently this report considers the implications for the Markham Willows project primarily within this sub area. The report also looks at the overall picture for Derbyshire in the context of the use of the composting facility at Markham Willows.

1.3 Aims of the report

The Markham Willows Project has a number of key elements that will be integrated to provide an environmentally sound and sustainable project for a proportion of the 320ha the north tip of the former colliery. Future developments could see the principles extended to similar applications both at the Markham site and at other sites in the county or further afield

The aim of this report is to provide a detailed analysis of the issues involved with the development of the composting component of the Markham Willows project, and to provide an approach which is fully integrated with Derbyshire's overall waste strategy and that supports overall goals of the Markham Willows project.

The key elements of the Markham Willows Project are

- The establishment and ongoing harvesting of Short Rotation Coppice as a harvested fuel. Additionally the willow in the coppice will lock in pollutants in the coal spoil through the process of phytostabilisation and reuse of biodegradable materials.
- The composting of biodegradable materials to provide nutrients and humic substances for the establishment of a new topsoil horizon and for the ongoing support of the willow plantations.
- Use of the harvested willow to provide wood fuel for use in heating systems for factories and offices, which will be established on MEGZ.
- The creation of a community company to manage the development of the SRC and composting activities and the sale of heat supporting long term sustainable employment.

The project will become part of an integrated approach to waste management in the county as envisioned in the Derbyshire Waste Management Strategy 1999 and Waste local plan. (Derbyshire Waste local Plan 2003)

1.4 Scope of the Report

The report will propose an approach for the Markham Willows composting project in terms of

- Waste collection strategy.
The report will look at the overall strategy that is envisioned by the county and

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review its impact for the short, medium and long-term viability of the composting facility.

- Compostable waste arisings.
The report will consider the potential wastes available and their suitability for the facility, taking into consideration local authority waste collection strategy and practice and waste that may be available from the private sector.
- Composting techniques.
Review of the technical merits and constraints of different composting systems with reference to their use within the regulatory framework
- Markets for compost.
Review of the markets for compost and the sustainability of the composting operations
- Regulatory Review.
Review of current and future regulatory constraints that may affect the facility.

1.5 The nature of regional waste problems

The UK Government's policy document (Waste Strategy 2000) sets out specific targets for local authorities to recycle and compost-increasing proportions of the municipal waste stream. The key targets of this strategy are

- To recycle or compost at least 25% of household waste by 2005
- To recycle or compost at least 30% of household waste by 2010
- To recycle or compost at least 33% of household waste by 2015

The UK is also required to implement the EU Landfill Directive. The aim of the Directive is to reduce the production of the greenhouse gas, methane, which occurs when biodegradable waste decomposes in the absence of oxygen.

The Landfill Directive requires that

- By 2010, the amount of biodegradable waste land filled is reduced to 75% of that produced in 1995.
- By 2013, the amount of biodegradable waste land filled is reduced to 50% of that produced in 1995.

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- By 2020, the amount of biodegradable wasteland filled is reduced to 35% of that produced in 1995.

The waste strategy and Landfill Directive have required local authorities to make significant changes to the way that they collect and dispose of waste, Derbyshire County Council published its intentions for dealing with the Strategy and Landfill Directive in The 1999 Derbyshire Waste Management Strategy. This document sets out the targets for the county and looks at the strategies that will be implemented to achieve the Landfill Directive targets.

One effect of the waste strategy and the Landfill Directive is to drive local authorities to separate recyclable and recoverable materials from the household waste stream. The separated materials are known as “dry recyclables” and “biodegradable waste”. The dry recyclables are materials such as paper, card, plastics, ferrous and non-ferrous metals, glass and textiles. Biodegradable Wastes are materials such as food waste, vegetables, plants and garden wastes, low grade paper and card and can be composted for reuse as soil conditioners and mulches. The remainder of the waste stream is generally known as the residual waste. Table 8 reports the composition of household waste in Derbyshire.

Table 8: Household waste arisings across Derbyshire⁷

| House hold waste arisings % & Classification | North East sub area | South Eastern sub area | Western sub area | Audit Commission Report 1997 |
|---|----------------------------|-------------------------------|-------------------------|-------------------------------------|
| Paper (DR) | 17 | 32 | 27 | 33 |
| Glass (DR) | 6 | 10 | 10 | 10 |
| Metal (DR) | 7 | 8 | 8 | 7 |
| Textiles (DR) | 2 | 4 | 4 | 2 |
| Plastics (DR) | 5 | 7 | 8 | 11 |
| Biodegradable (OW) | 25 | 20 | 30 | 20 |
| Ash /dust (R) | 17 | 5 | - | - |
| Unclassified (R) | 23 | 15 | 15 | 17 |

Note DR = Dry Recyclables, OW= Biodegradable waste, R= Residue Waste

⁷ Taken From Derbyshire Waste Management Strategy 1999, Appendix C, Page 71

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In order to meet the UK Government and Derbyshire Waste Management Strategy targets, significant diversion of the target waste streams from current rates is required in Derbyshire. When these diversion targets are converted to actual tonnage of materials to be recycled or composted, it can be seen that a major shift in collection, treatment and disposal will be required.

For example, Derbyshire, (excluding Derby City) produced 366,277 t⁸ of household waste as reported as its Best Value Performance Indicator for 2002/3. Assuming that biodegradable waste comprised an average of 25% of the total waste arising, the potential biodegradable waste available would be circa 91,000tpa. In 2003, Derbyshire composted 3.69% of the total waste stream of 366,277tonnes, equivalent to 13,529 tonnes⁹. Table 9 indicates waste classification, using the three main waste components, based on sub classification shown in Table 8

Table 9 Waste classification by area

| Classification | North East sub Area | South Eastern sub area | Western sub area | Audit Commission |
|-----------------------|----------------------------|-------------------------------|-------------------------|-------------------------|
| Dry recyclables | 37% | 61% | 57% | 63% |
| Biodegradable waste | 25% | 20% | 30% | 20% |
| Residual waste | 40% | 20% | 15% | 17% |

Note (1) Imbalances are assumed to be due to rounding up.

Note (2) Variance in the North East sub area is thought to be due to the predominance of coal fires and concessionary fuel.¹⁰

The recovery, treatment and disposal of wastes has been complicated by the BSE crisis and foot-and-mouth. The UK Government introduced a ban on the composting of catering waste (waste produced in shops, canteens, restaurants, etc) in an attempt to prevent the reoccurrence and spread of foot-and-mouth disease through contaminated meat products. While introduced with good intention, this ban prevented the composting of all biodegradable waste streams unless it could be demonstrated that the materials to be composted had not been contaminated by meat products. Biodegradable waste from households was considered to be potentially contaminating and so components derived from it could not be spread onto pastureland. As a result, composting of biodegradable waste containing catering waste stopped in the UK and temporarily prevented a key delivery mechanism of the Waste Strategy 2000 and the Landfill Directive from being achieved. The ban also caused delays to planned composting plants until clarification or a change in the regulations could take place.

⁸ Personal communication Ovens R3 and Derbyshire Environmental Services Department. September 2003

⁹ Personal communication Ovens R3 and Derbyshire Environmental Services Department. September 2003

¹⁰ Derbyshire Waste Management Strategy 1999, Appendix C ,page 71

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Composting of green wastes such as garden waste, tree pruning and materials collected during the maintenance of parks and gardens were still allowed. Mostly these materials are composted in relatively simple open composting systems, often located at landfills and farms.

In July 2003 the UK Government ban was superseded by the Animal By-Products Regulation (EC 2002) which is a statutory regulation setting out the criteria for the composting of materials which are classified as containing catering waste. This order is a European wide standard for the composting of catering waste. (The effect of these developments on Markham Willows composting is discussed in Chapter 4)

It is in this regulatory context that the Markham Willows project needs to be integrated into the overall waste management strategy. This report sets out to identify the targets, drivers, regulatory impacts and constraints which may impact on the project and seeks to provide a firm strategy for the development of a composting facility in support of the Short Rotation Coppice scheme which forms a wider part of the Markham Willows project.

2. Local effects and strategy

2.1 The Markham Project at the Local Level

Markham Willows has the potential to develop into a regional processor of household compostable waste serving much of Derbyshire. However there are many factors that might effect this development such as transport, infrastructure, treatment of waste according to the proximity principle, and political and commercial considerations. These factors vary greatly at a local level.

2.2 Waste strategy recycling and composting targets

The county of Derbyshire must meet national recycling and landfill diversion rates. In order to met these targets, significant tonnages of recyclable materials will need to be either source separated by householders or processed in Mechanical Biological Treatment (MBT) facilities to remove recycle and biodegradable materials. To understand the scale of this diversion, the Best Value Performance Indicators (ODPM 2003) reported by Derbyshire for 2002/3 show a recycling and composting rate of 14% that removed 50,220t of materials from the waste stream. In order to meet the target of 25% recycled and/or composted by 2005¹¹, circa 91,500 t will need to be removed from the same waste stream, a little short of a doubling of the current effort.

Table 10 Derbyshire County BVPIs for 2002/3 (excluding Derby City)

| BVPI 82a &82b | Tonnes | Percentage |
|---|---------|------------|
| Total household waste | 366,277 | |
| Total recycled (inc. CA Sites ¹²) | 36,691 | 10.02% |
| Total composted (inc. CA Sites) | 13,529 | 3.69% |
| Total Recycled and composted | 50,220 | 13.71% |
| Total recovered | 118 | 0.03% |

2.3 Landfill Directive

There is a significant opportunity to recover the biodegradable content from the household waste stream and the Landfill Directive requires that by 2010, the amount of biodegradable waste landfilled be reduced to 75% of the amount landfilled in 1995. Using National and Derbyshire statistics, it can be assumed that the percentage of biodegradable materials within the overall waste stream is likely to be between 20-30%. Refining this range to a more precise figure in line with National and Derbyshire statistics, it is possible to predict the range of biodegradable materials that are potentially available to be diverted from the DCC waste stream. The calculations to support this prediction are attached as Appendix C: -Chart 1, Prediction of

¹¹ The first specific target in Waste Strategy 2000

¹² Civic amenity sites abbreviated to CA sites. Used by the public as a disposal centre for household waste from houses and gardens not collected by the local authorities.

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Availability of Biodegradable Waste in Derbyshire.

In a report for the Welsh Assembly carried out by AEAt in December 2003, the biodegradable content of household waste is reported as comprising 36% of the waste stream. (AEAt 2003), Therefore it would see reasonable to use a conservative figure of 25% as the biodegradable content of Derbyshire waste.

2.4 Biodegradable waste prediction modelling.

A set of calculations has been made to determine the level of biodegradable materials landfilled in 1995, illustrated in Figure 2. This review uses the following model to predict likely biodegradable waste arisings. The calculation is based on the assumption that waste has increased by a set amount each year. The Derbyshire 2002 BVPI is used as the starting point for making this calculation and assumes a constant escalation of waste over the period 1995-2010.

The modelling assumes there are four key scenarios that could affect the availability of biodegradable materials

- Rapidly increasing waste arising with a high biodegradable content (waste increases each year by 3%). Shown as High waste, High organics. (HWHO)
- Rapidly increasing waste arising with a low biodegradable content. Shown as High waste, Low organics (HWLO)
- Slowly increasing waste arising with a high biodegradable content (waste increases each year by 1%.) Shown as Low waste, High organics (LWHO)
- Slowly increasing waste arising with a low biodegradable content. Shown as Low waste, Low organics (LWLO)

Using a low waste escalator of 1% and a high waste escalator of 3%, the model will produce a prediction for the tonnage of waste produced over the period of 1995-2010.

Applying a factor of between 20% - 25% as the expected biodegradable materials content of the waste produces results for the four scenarios above.

Figure 2 Predictions of biodegradable waste arisings for Derbyshire.

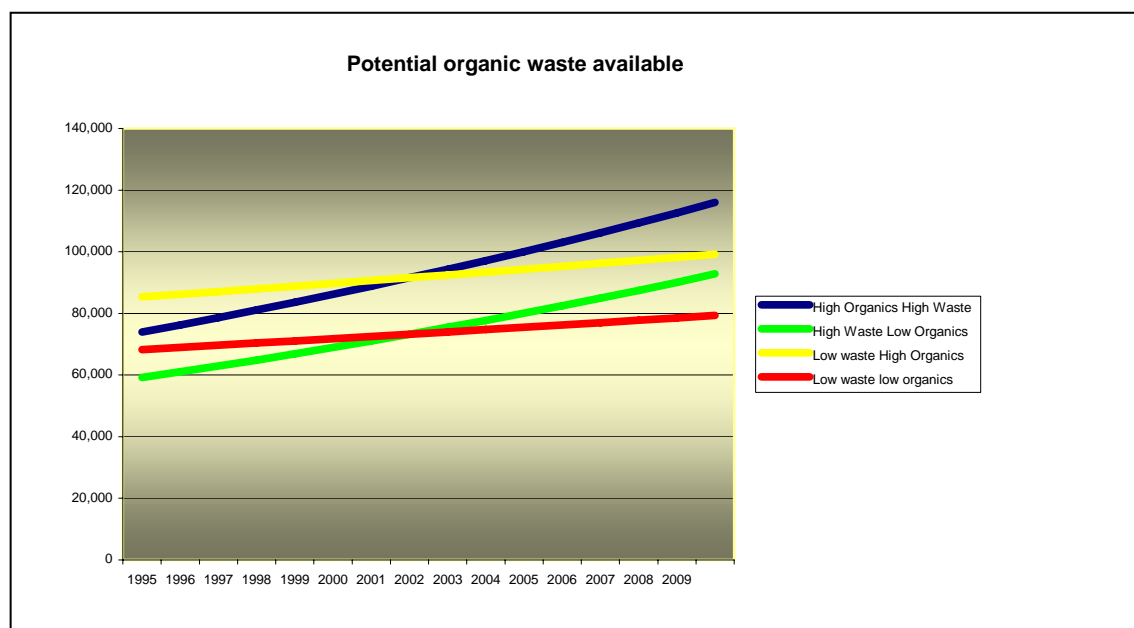


Figure 2 indicates the potential tonnage of biodegradable waste that could be available within the household waste collected across Derbyshire for each different scenario.

The Landfill Directive requires that level of biodegradable materials sent to landfill should be reduced to 75% of 1995 levels by 2010. Using the BVPI figures issued by Derbyshire, the calculations indicate that circa 50,000 to 60,000t of biodegradable materials could be landfilled in 2010 by Derbyshire with the county still remaining in compliance with the Landfill Directive.

The model indicates that, based on the declared Derbyshire 2002 BVPI figure of 366,277tonnes of waste collected, approximately 73,000 tonnes to 92,000 tonnes is potentially biodegradable waste. Using the same inputs, the scenario predicts that the amount of biodegradable waste potentially in the Derbyshire waste stream could increase to 79,000-115,000 tonnes by 2010.

This suggests that in the region of 30,000 to 60,000t of biodegradable waste needs to be diverted from landfill on a yearly basis by 2010 if Landfill Directive targets are to be met. (See Appendix C, Chart 2 Waste model 2).

Composting facilities at the Markham Willows site, as part of Derbyshire’s integrated approach to waste treatment, would be well placed to provide facilities to deal with the required diversion of biodegradable wastes utilising suitable processes such as “in vessel” composting or anaerobic digestion. A 10,000 tpa composting facility would provide 16-33% of the necessary biodegradable waste diversion.

2.5 Markham Willows location

The Markham Willows project site is located approximately 10miles east of Chesterfield and in the approximate centre of the area classified by Derbyshire

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County Council as the North East subarea, which comprises three local authorities, which are: -

- District of Bolsover
- North East Derbyshire District Council
- Chesterfield Borough Council

Located in Chesterfield is the Stonegravels Civic Amenity (CA) site, which is the nearest CA site to the Markham Willows project and a potential source of green waste for composting activities at the Markham Site.

2.6 Population.

Based on 2001 census figures¹³, the three councils are reported to be responsible for the following number of households.

- | | |
|--|--------------------|
| • District of Bolsover | 36,248 households |
| • North East Derbyshire District Council | 43,462 households |
| • Chesterfield Borough Council | 40,693 households. |

This is a total of 120,403 households which can be considered within the Markham Willows “Catchment” area and is a figure that can be used to develop potential green waste arising using National waste statistics.

2.7 Potential availability of green waste.

Defra published its Municipal Waste Statistics report (Defra 2003a) for 2001/2, which is the last reported year for these statistics. The statistics report that an average figure for compostable waste arising from CA sites is 38.9 kg per household (Defra 2003b) It should be noted that this is a ratio, which is calculated using the total number of households in England and total number of arisings in England where there may well be regional differences in this ratio.

Using the average figure as a multiplier for the number of households in the North East subarea of Derbyshire, an indication is reached of potentially 4,700 tonnes of compostable waste may be available from CA sites within the area.

Annual kerbside collection rates from source separation schemes expected by SITA¹⁴ are 150 to 200 kg per household, with the Scottish Executive Environment Group (Research Report 2003) found collection rates shown in Table 11

¹³ Data on number of households provided in a personal communication from Derbyshire county Council, Environmental Services in response to an email from Ovens, R3 Environmental Technology, 24th September 2003

Table 11. Collection data from source separation schemes.

| Collection Scheme. | Collection Rate - Weekly | Collection Rate - Annually | Participation |
|---|-----------------------------------|-----------------------------------|--------------------------|
| Hounslow: green sack collection, garden waste only | 0.1 kg / hh / wk | 5.2 | 10.3% participation rate |
| Bath and NE Somerset, sack collection, garden waste only | 2 tonnes per month from 67,000 hh | 0.7 | n/a |
| Braintree, wheeled bin, kitchen and garden waste | 3 kg / hh / wk | 156 | 48% |
| Daventry, wheeled bin, kitchen and garden waste and cardboard | 6 kg / hh / wk | 312 | 42% |

Hence potential diversion of green waste from the 120,403 households in the North East subarea of Derbyshire, using separate collection and assuming an average collection rate of 150kg/ hh/year, is potentially in the region of 18,000 tonnes per annum at current levels of waste arisings. (Note this might also lead to a reduction in green waste collected from CA sites.)

Overall the maximum potential green waste arising in the area could be as high as 20,000 tonnes per annum, at current levels of waste production, and could be much higher if kitchen waste and cardboard are also collected. In practice 100% separate collection coverage, and 100% diversion rates cannot be achieved.

Derbyshire County Council predict that there may be 6,000 tonnes of green waste available for the North East subarea districts, but this figure has not yet been confirmed.¹⁵

A facility of 10,000 tpa capacity seems comfortably within the potential green waste arising for the area. (6,000 to 20,000 tpa) which has been used as the basis for the composting facility discussed in this report.

¹⁴ Personal communication Ovens R3 and SITA.

¹⁵ Verbal indication given by DCC at a meeting with Ovens, R3 Environmental Technology, on 6th October 2003

3. Waste availability, composting techniques and markets

3.1 Separately collected household biodegradable waste.

Current legislation classifies biodegradable waste in the household waste stream as “Catering Waste” and as such, requires it to be composted to a specific set of conditions that comply with the Animal By-Products Order. This is a statutory order introduced in the wake of the BSE and foot-and-mouth epidemics. The aim of the order is to prevent the re-occurrence and spread of these diseases by preventing the distribution of pathogens that can be carried in compost that has been improperly stored or processed, and which is subsequently spread on grazing land.

The effect of ABPO is to require compost facilities appropriate to the materials that are being composted. The result is a two-tier system in which organic wastes that have had no contact with meat or meat products can be composted in a relatively low tech and low cost “windrow only” system. All other compostable materials require a much higher standard of containment with a more rigorous operating regime. These are generally referred to as “In vessel” composting systems and have higher capital and operations costs.

Biodegradable waste, which originates for domestic households, can be spilt into a number of categories as shown in Table 12.

Table 12 Generic composition of household waste

| Generic type of waste. | Consisting of. | Commercial scale treatment option |
|---------------------------|--|--|
| Green or garden waste | Grass clippings, shrubs, weeds, flowers, leaves, etc | Turned windrow |
| Catering waste | Vegetable trimmings, fruit peelings, raw and cooked food waste. | In-vessel composting system complying with ABPO Regulations |
| Other biodegradable waste | Card, paper, biodegradable packaging, disposable nappies and incontinent pads, miscellaneous organic materials | In-vessel composting system complying with ABPO Regulations or preferably incineration |

A compostable waste, that does not require specialist treatment and which is available from the household collection system, is green or garden waste. This is biodegradable waste from the garden only and does not include kitchen materials, vegetable stalks, etc, but does allow shrubs, grass cuttings, bushes, etc and as such is exempted from the constraints of the Animal By-Products Regulations.

This is the target material for most source separation schemes provided by local authorities across England. Additionally, sources of green waste may be found within the private sector, arising from such businesses as tree surgeons and garden maintenance contractors; the size of

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this arising is difficult to estimate.

3.2 Alternative Biodegradable Waste

Groundwork Creswell identified potential alternative biodegradable waste streams in a supplementary report. (Groundwork 2003) These waste streams are summarised in Table 13. It was considered from the outset that the study should include the potential procurement of compostable materials from the private sector, wherever it was considered to be likely that there was a likelihood of obtaining reasonable quantities of suitable (animal by-product free materials) within the vicinity of the site and with reasonable prospects of achieving a gate fee either initially or within the medium term.

Table 13 Potential private sector waste identified by Groundwork Creswell.

| Private sector waste arising. | Comments | Tonnage suggested in Procurement report |
|--|---|--|
| Brewers | Not considered viable due size, other market outlets | 0 |
| Garden centres | Identified in the procurement report but no indication of tonnage available. | 0 |
| Manufacturers of animal product free foods | Identified in the procurement report but no indication of tonnage available. | 0 |
| Supermarkets | Identified in the procurement report but no indication of tonnage available. | 0 |
| Water companies | Severn Trent have sewage sludge available | 20,000 to 30,000 |
| Farms | Mentioned in procurement report but no indication of tonnage, Not considered viable | 0 |
| Private waste collectors | Mentioned in procurement report but no indication of tonnage, | 0 |

Further research into the availability of additional forms of biodegradable waste may depend on the final form of composting system chosen for the Project. Groundwork Creswell are currently commissioned to produce a business plan for composting at Markham Willows and will probably revisit this area.

3.3 Use of materials from MBT.

Biodegradable waste is a major component of the household waste stream. In the past biodegradable waste has been mechanically extracted for composting or digestion. However, these mechanically separated compostable fractions tend to retain an unacceptable degree of

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contamination from such materials and plastic and glass. Furthermore it appears that once green wastes have been mixed with other wastes they become contaminated by potentially toxic elements such as lead and cadmium and that the contamination is largely irreversible. Therefore efforts to produce high quality compost from wastes now focus on procure ring separately identified biodegradable wastes. Composting may still be used to treat mechanically separated fractions of either whole refuse or residual waste. This approach yields lower grade compost with limited usefulness. It is now generally seen as one possible component of MBT. (CIWM 2002 Environment Agency 2001)”.

3.4 Generic types of composting systems

Composting approaches can be divided across four basic categories:

1. The traditional compost heap as used by farmers and gardeners, where the only aeration (apart, perhaps, from that provided by manual turning) is provided by diffusion, assisted by convection currents as the waste self-heats. The main problems are that the system can quickly become anaerobic and therefore can produce unacceptable odours when the pile is disturbed. Diffusion and the movement of air by convection also contribute to aeration in the following composting systems, although their contribution to the overall supply of air is generally small (not considered further in this review).
2. Using turned windrows, where elongated piles (windrows) are formed and turned according to a regime that aims to maximise the rate of degradation. Turning has the advantage of exposing fresh surfaces to degradation processes.
3. The aerated static pile, where air is forced through heaps of compostable materials. Aeration is controlled according to temperature or time or both, to maximise degradation. Aeration may be positive (blowing) or negative (sucking). No mixing of the waste is carried out once the pile has been constructed (hence static).
4. In-vessel systems, which utilise turning or forced aeration or both. These are generally variations and combinations of the basic control methods of mechanical turning and forced aeration, although the fact that the composting material is enclosed means that the ability for control of the process can be enhanced.

3.4.1 Windrows

Long piles of feedstock (windrows) about 2 to 3 m high and 3 to 6 m or more wide are constructed, with a roughly triangular cross section. These windrows are arranged in rows, and are allowed to degrade. The process is accelerated by turning the feedstock, manually or using a front loader or specialized machinery. Although this process has the advantage of simplicity it does have some drawbacks. The main disadvantage is that a large land area is required to cope with the long process retention time (about three months or more in the UK, but considerably less in tropical climates). The windrows must be made on hard standing (concrete or asphalt see Figure 4), since soil surfaces will be rapidly eroded by the windrowing process. (CIWM 2002, Environment Agency 2001).

Composting may be retarded or may be incomplete if anaerobic conditions are able to develop in some parts of the heap. Turning of the composting material is necessary to aerate the

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material and ensure that anaerobic conditions do not occur. The required frequency of turning is determined by the activity of the pile and more active composting requires more frequent turning. To a point the converse is also true, that more frequently turned compost windrows are more active as the oxygen levels are maintained closer to atmospheric levels. In the early stages of composting of green wastes, turning two or three times a week is appropriate as this is a reasonable compromise between maintaining pile temperature and keeping the oxygen level high enough to avoid anaerobic conditions. Some commercial operations do turn less frequently than this (once a week), which runs a higher risk of producing odours, and may slow the process slightly. Later in the composting process the turning rate should be reduced (once per week) so that temperatures are maintained above sanitisation temperatures. Obviously operating a plant to a differential turning rate is managerially more complex and thus is one of the main reasons why many operators practise weekly turning throughout. Movement to more putrescible feedstocks, i.e. those green wastes collected at the kerbside, may make the early stage frequent turning imperative due to the enhanced potential for odour generation.

There are no specific suppliers of systems for this technology, but individual items of plant that are required can be identified as front end loaders, turning machines, shredders and screens (see Appendix B). The requirements of the Animal By-Products Order will most likely increase the costs of these operations as the waste reception and first stage of composting will have to be enclosed. In addition the separation of “clean” and “dirty” operation will from an operational point of view lead to duplication of key equipment items such as loaders.

Using a windrow only system will only be possible for green waste which is available from sources which can demonstrate compliance with DEFRA guidelines for green waste. Materials, that do not comply and are classified as catering wastes, would need to be taken off site for processing at suitable facilities.

Green waste mixed with catering waste must be considered as catering waste and treated accordingly. A bin full of grass cuttings and kitchen vegetable peelings would therefore be considered to be catering waste. If the vegetable peelings were placed directly in a dedicated bin or other container, and had never been mixed with the meat fraction of the kitchen waste, the contents could be considered to be ‘meat-excluded’ catering waste. The same approach applies equally to material collected at the kerbside from domestic properties and to material collected at centralised facilities such as civic amenity sites and recycling centres.

3.4.2 Aerated static pile systems

Aerated static pile systems (CIWM 2002, Environment Agency 2001) do not employ mechanical turning. Aeration is provided by fans or blowers, which force air through the composting material using either positive aeration (blowing air outwards from the base or centre of the pile) or negative aeration (sucking air inwards from outside the pile) or a combination of both. Aeration may be provided through perforated pipes set within the piles, or the piles may be built on specially constructed floors set above a venting system. It is usually necessary to cover the perforated pipe or grid with material such as straw or wood chips to prevent the air inlets from becoming blocked with small particles from the compost feedstock. The piles may be covered with inactive material, such as recycled compost, to reduce odour emissions and to retain heat during the thermophilic stage of the process, since

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otherwise the surface layers of the pile would be unlikely to maintain temperatures in the thermophilic range. Aeration is controlled according to time (for example, 5 minutes aeration every half hour, depending on the capacity of the blower and the volume of material to be aerated) or temperature (whenever the measured temperatures within the pile exceed a fixed level, usually 55 to 65⁰C), or a combination of the two. Aerated systems allow faster composting than windrow systems, so the land requirements for a similar throughput of feedstock are lower, and this can provide a significant cost benefit over windrow composting where space is at a premium. However, aerated static pile composting also suffers from some disadvantages. Capital costs tend to be somewhat higher than traditional windrowing, although labour costs are likely to be lower. It can be difficult to ensure temperature control and adequate aeration and moisture levels throughout the pile.

3.4.3 Rotating drum

Feedstocks are introduced into one end of a slowly rotating drum, inclined at about 5 degrees from horizontal. Moisture may be supplied as water or as sewage sludge. Aeration is promoted by the tumbling action of the materials. The combination of physical attrition and microbial degradation causes “wet pulverisation” of the material. The most common commercial version of this system is the "DANO Drum". Retention times vary from 4 to 6 hours to 2 to 3 days. This length of time does not permit a significant amount of composting activity to take place, but the drum does allow the homogenisation and screening of materials for subsequent composting.

3.4.4 In-vessel systems

A wide variety of engineered systems exist for carrying out composting under contained conditions. These systems provide for greater control of the composting process, allowing the temperature, moisture content and air supply to be tailored closely to the requirements of the decomposition process, and usually enable better control of emissions such as odour and leachate. Low retention times (often less than 14 days) are often employed in in-vessel systems. Typically the processing time allowed is insufficient for completion of the thermophilic composting stage, and further compost processing is required for materials leaving the compost reactor.

It is likely that 10- 14 days in-vessel composting would be adequate to allow treatment able to comply with animal pathogen regulations providing that the temperature-time provisions of the ABPO are met. The subsequent composting step, which would be windrow composting, is required for compliance with animal pathogen regulations as it is an additional level of processing. Increasing the number of processing stages is seen as enhancing process risk management in terms of pathogen control.

The photograph shown is a typical “In-vessel” clamp type composting system. These units are modular and will comply with the requirements of the ABPO order and the Defra guidelines. The infrastructure at Markham Willows as required by Defra, would be designed to be expandable on a modular basis to allow further In-vessel systems to be provided if there was sufficient demand.

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In-vessel composting systems are, by their nature batch process systems and therefore the capacity of a composting facility would be set by the process cycle of the “in-vessel” system. Table 14 sets out the criteria for establishing the number of “in vessel” units required for a Markham Willows facility with a capacity of 10,000tpa. It should however be noted that this simple calculation does not take into consideration seasonal variations in waste delivery, so some over capacity would need to be built in to the calculation.

Table 14 Results from a simple model for predicting in vessel capacity

| | | | |
|---------------------------------|---------------|------------------------------|---------------|
| Clamp capacity (Input t) | 175 | Number of weeks operational | 48 |
| Fill time days | 1 | Number of days available | 336 |
| Process time days | 14 | Theoretical cycles | 21 |
| Empty and clean | 1 | Theoretical capacity (input) | 3675 |
| Fill, process, empty cycle time | 16 | Theoretical Total capacity | 11,025 |
| | | | |
| Input capacity required | 10,000 | Number of units required | 3 |

Figure 3 Typical in-vessel composting clamp



The operation of the type of in-vessel system shown above is robust and agricultural in nature, using front-end loaders and purpose built handling equipment. However the ABPO and DEFRA guidelines will require good management control and practice to ensure compliance with the regulations. This includes separation of incoming waste and processed materials if the waste is considered to be catering waste or Category 3 waste.

3.5 Composting Site Infrastructure.

Requirements for development of the site infrastructure will have common aspects, irrespective of the type of composting system that will be utilised. These common aspects include access roads, equipment storage areas, and hard standing for windrows.

Most composting sites will require some dedicated infrastructure or the ability to use common facilities. These will include office and mess facilities, weighbridge, maintenance and an equipment cleaning bay.

3.5.1 Composting of Category 3 and Catering Waste

This type of facility must have covered storage areas for the reception of Category 3 and catering waste materials are held prior to the composting operation.

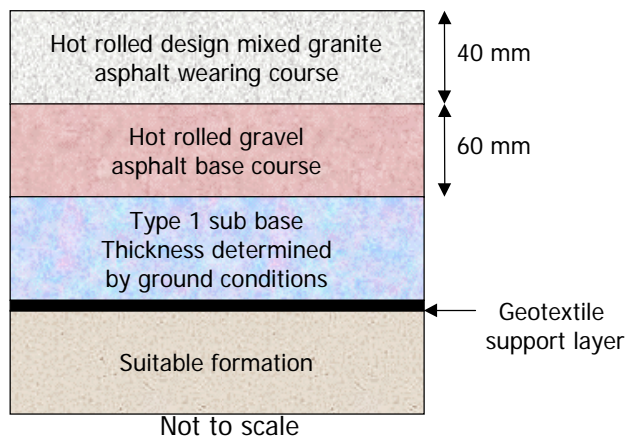
There shall be (a) a reception area in which untreated animal by-products (including catering waste) are received; (b) an area in which vehicles and containers are cleansed and disinfected with adequate facilities for doing this; and (c) a clean area in which treated compost or digestion residues are stored. (Defra 2003)

The storage area will require specific drainage arrangements to be made to trap residues washed or leached from the waste. All these facilities will require inspection and approval by the State Veterinary Service prior to operation.

3.5.2 Construction of Windrowing Pads

Both green waste windrows system and the subsequent windrowing of Category 3 products for the second barrier treatment require permanent concrete or asphalt pads to withstand continued equipment movement and facilitate drainage for leachate collection purposes.

Figure 4. Typical hard pad construction.¹⁶



Leachate collection is required to prevent pollution of water courses. As the windrowing operations are carried out in the open air, the collection systems must be capable of containing significant quantities of rainwater run off. The leachate is then either treated in on-site treatment lagoons using such techniques as reed beds or as a controlled release to a foul sewer system. Leachate and run off water are also used to provide moisture to the composting process when required.

The rim of the lagoon will need to line up with the level of the kerb edge of the composting pad. The lagoon provides the main source of water storage and acts as the reservoir for the water re-circulation scheme. The basic capacity of the lagoon is based on 1 m³ of runoff per

¹⁶ Typical specification as used by SITA for their large composting operations. Personal communication Ovens R3 Environmental Technology and SITA.

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20 m² of hard standing, a rule of thumb used throughout Europe for the design of composting facilities¹⁷.

3.6 Compost facility Gate fees

Current market rates (gate fee) for green waste materials delivered to composting systems is in the region of £15 to £25/t. The lower end of the price range being dominated by small on-farm enterprises operating without the fixed overheads of the larger capacity operations.

Cost modelling by AEAt suggests that for 6,000tpa input level, with a discounted gate fee and utilising shared use of equipment and labour, operating costs may be covered by gate fees. However, income would be sensitive to commercial pressures such as fluctuations in waste volumes. A facility would need to process 10,000 TPA or more to be fully commercially viable.

3.7 Compost Use

Composts are a relatively low value product. Revenues for bagged composts are in the order of £25 to £100 per tonne (based on £0.50 to £1.50 wholesale and £2.00 retail per 40 litre bag¹⁸, and bulk density of 500 kg.m⁻³). For many applications, even high grade applications such as horticultural production, compost producers are unlikely to achieve this retail value, for example for composts sold unbagged in bulk. Dampney (2002) reports that the compost produced by *Eco-Composting* in the UK sells more than 90% of production at an average price of £9 per m³, encompassing bagged and unbagged product. The Composting Association survey (Slater *et al.* 2001) found that 462,768 tonnes of composted material were produced in the UK during 1999, accounting for 55% of total feedstock material. Approximately a third of composted product was used as mulch, and a third was used as a soil conditioner. The remaining third comprised daily landfill cover, remediation material, growing media and topsoil. Quantities and proportions for each product are given in Table 15

¹⁷ Personal communication. Ovens, R3 Environmental Technology and SITA.

¹⁸ Typical costs suggested by SITA (Wise 2002, Personal Communication) and AEAt (Wheeler)

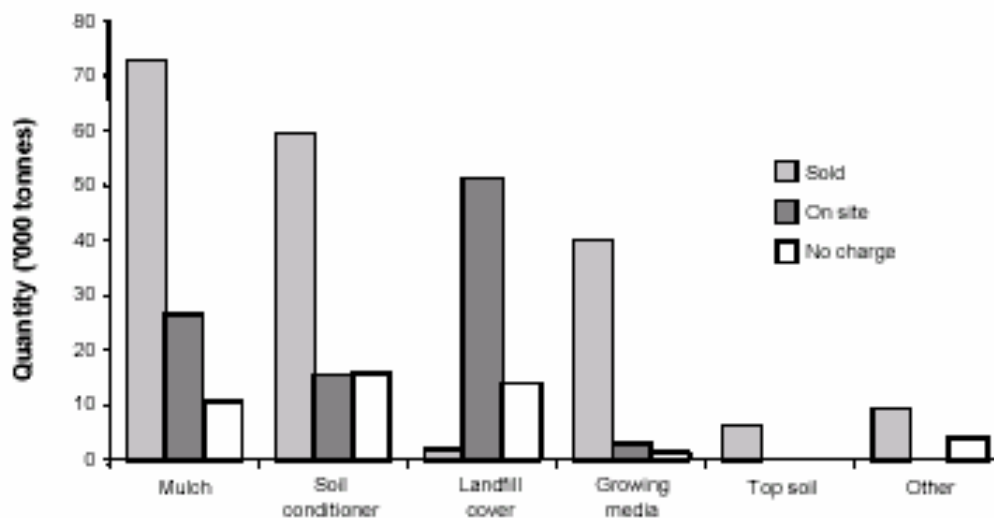
Table 15 1999 Production of Composts by Application (Slater et al. 2001)

| Composted Product | Tonnes | % |
|-------------------------------------|---------|------|
| Mulch | 166,772 | 36.0 |
| Soil conditioner | 164,480 | 35.5 |
| Landfill cover/remediation material | 66,132 | 14.3 |
| Growing media | 43,126 | 9.3 |
| Top soil | 9,000 | 2.0 |
| Other | 13,258 | 2.9 |
| Total | 426,768 | 100 |

Slater *et al.* (2001) suggest that of all composted material (for which responses to the survey were received), 57% was sold, 29% was used on-site, and 14% was distributed free of charge. These overall distribution proportions are different for each product type. Around 66% of mulch was sold, 24% was used on-site and 10% was distributed without charge. Around 66% of soil conditioner was sold, 17% was used on site, and 17% was distributed without charge. Around 76% of daily landfill cover was used on site, 21% was distributed without charge, and 3% was sold. 90% of growing media was sold (see Figure 3).

77% of material sold was distributed in bulk, and 23% was bagged. Of the composted material sold in bulk, approximately 50% was mulch, 34% was soil conditioner, and the remainder included growing media and top soil. Of the bagged composted material, 80% was growing media, 14% was soil conditioner, 5% mulch, 1% top soil and other. For composted material that was sold, most customers were commercial landscapers and commercial gardeners, followed by garden centres and hobby gardeners. In addition to these main customers, composted material was also sold to organic growers, local authorities, golf courses and building companies. Note: not all producers completed this section of the survey, leaving, 129,955 tonnes of composted material unaccounted for in terms of end-use and distribution.

Figure 5 Quantities of compost in 1999 known to have been sold, re-used on site or given away free (Slater et al. 2001).



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Table 16 summarises the operations of five “best practice composting sites” reported by WRAP (WRAP 2002a). These sites represent a similar range of operations to those envisaged by the proposed Markham Willows facility (5,000 to 25,000 tonnes of input pa). The materials used tend to be green wastes from civic amenity wastes, with some sites also using kerbside collected segregated wastes, and wastes from commercial sources.

The yield of product by mass has been reported for two of the five WRAP case study sites as 48% and 60%. AEA suggest that yields of 55 to 70% by mass are usual. A significant proportion of this mass is water absorbed during windrowing and maturation. The remainder of the input mass is lost as carbon dioxide and water vapour as a result of biodegradation - approximately 20% by mass, or is a reject fraction (i.e. contrary material, oversize) - approximately 10-15% by mass. Material tends to be graded at between 5 and 10 mm, and the undersize sold as soil conditioner or soil improver. Larger sized materials, e.g. 5 to 40 mm tend to be sold as mulch. Screening may also take place at an intermediate size (25 or 28 mm).

In two cases the local authorities are one of the major customers for product. For two other cases Private Sector clients are the main users. None of the case studies exploit sales from a CA site, sales to the public, such as local professional gardeners, or direct sales, for example to allotment holders or householders. Golf courses have also been seen by other producers (e.g. HLC in Wales) as a potentially important market. All five sites are in the process of obtaining accreditation from the Composting Association. Two composts have been certified by TCA so far, with other organisations understood to be undergoing assessment include: WRG, Sita, Premier Waste Management, Eco-Composting, Cleanaway and EQ Waste Management (Anon 2002d and 2002j)

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Table 16 Summary of WRAP Best Practice Composting Site Case Studies (WRAP 2002a)

| Name | CERT, Nantycaws | Cleanaway, Pitsea | CRS, Cambridge | Hants Waste Services, Fareham | WRG, Chester |
|-----------------------------|---------------------------------|--|------------------------------|--|---|
| Date established | 2001 | 1987 | 2001 | 2000 | 1999 |
| Feedstock | CA GW | CA GW (70%) Kerbside K&G waste (30%) | County GW, commercial wastes | CA GW, kerbside garden waste, commercial | Green waste from LAs |
| Capacity (tpa) | 5000 | 25000 | 10000 | 25000 | 12000 |
| Site staff | 3 | 4 | 1.5 | 6 | 2 to 6 |
| Output | | 12000 | | 15000 | |
| Key products | <25 mm mulch SC | <10 mm SI, <5 mm lawn humus, 5-40 mm mulch | SC | 5-30 mm SC, mulch, TD | <28 mm, <6 mm |
| QA | TCA in progress | TCA in progress | TCA in progress | TCA in progress | TCA in progress, ISO 14001 operation |
| Customers | LA, Nat Botanic Garden of Wales | Private sector | County Council, "Truelink" | Private sector | landscaping, landfill, restoration, agriculture, bagged product |
| Process | Turned windrow | Turned windrow, plans for in-vessel | in-vessel | Turned windrow | Turned windrow |
| Bagged Product sold? | ? | Yes | ? | Yes | Yes |

Key: CA = Civic Amenity Site; GW = green waste, K&G = kitchen and garden, LA = local authority
SC = soil conditioner, SI = soil improver, TD = top dressing, TCA = the Composting Association accreditation scheme

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As well as TCA accreditation, another scheme, the Apex initiative, offers an opportunity for the accreditation and promotion of bagged green waste compost products (www.apexcompost.co.uk) and is currently used by B&Q and J Arthur Bowers (William Sinclair Horticulture Ltd) brands. In 1997 the annual consumption of materials for growing media and soil improvers was estimated to be 3.5 million m³, of which 64% was peat. (ODPM 2003b) Under the umbrella of Apex, the waste companies Onyx, SITA and Cleanaway are collecting and composting green waste, which is distributed by Freeland Horticulture. Other supporters of Apex include: Wyevale garden centres, Homebase and Focus, and the scheme is also linked to the *Eden Project* in Cornwall. Composts sold to Apex must meet a product specification, although this is not available to the Public Domain. Compost production must also include a quality assurance (QA) scheme. The *Management and Auditing Scheme for Compost* operated by SITA meets APEX's QA requirements. *Gardening Which?* published by the Consumer Association is a very influential publication that carries out regular trials of composts. Achieving a recommendation from this magazine could be very helpful for sales.

In another successful venture, the *Warmer Bulletin e-news* (29/11/02) reports that Onyx are selling 30,000 tpa of a branded green-waste compost, called *Pro-Grow*¹⁹, throughout the UK. They have now developed a product range including: a “woodchip mulch”, “premium pine bark” and “lawn conditioner.”

The type of applications available is dependent on the age of the compost, which is related to two measures of compost quality:

- Maturity (a decreasing ability to cause phytotoxic effects due to incompletely degraded components)
- Stability (a decreasing ability to undergo further rapid biodegradation, releasing carbon dioxide, or under anaerobic conditions, methane).

Some applications require a mature and stable compost, in particular retail and professional gardening applications. Maturation of compost can take as long as three months after the “active” phase of composting has been completed. Other applications may be more tolerant of younger composts, for example agricultural applications where either the compost will be diluted in a large volume of soil, or the compost is applied some time before crops are planted. Indeed, the application of younger composts *may* be more beneficial for the development of soil structure than aged organic matter (Shephard *et al.* 2002).

Applications of compost are seasonal, so it may not always be possible to find immediate uses for young or more mature compost. Hence there may be periods of the year when compost is effectively stockpiled.

¹⁹ www.pro-grow.co.uk

3.8 Coarse and reject materials use.

The coarse grade composts that will be produced as part of the overall output from the facility will contain higher levels of oversize and contrary items. This material can be used in landfill sites for engineering works and daily cover or reprocessed through the composting system to improve overall quality.

The oversize fraction, which is predominantly wood, could be diverted to combustion systems provided that the overall specification of the materials was compliant with the combustion system manufacturer's requirements. This could involve further shredding or chipping to produce a specific fuel size range.

The Safe Compost Matrix reproduced below is extracted from a report produced by WRAP (WPAP 2002b) and which sets out uses for grades of compost, which could be produced at Markham Willows. It will be possible to produce composts which comply with BSI PAS 100 for use as a peat replacement and which corresponds to Grade A in the proposed Safe Compost Matrix.

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Figure 6 The Safe Compost Matrix (WRAP 2002b)

| Outlet | Sub-category | Multi-Purpose ¹ | General Purpose ² | Grade C | |
|---|--|---|------------------------------|-----------------|---|
| | | Grade A | Grade B | | |
| Agriculture^{4 5 6} | Fruit | √ | × | × | |
| | Salad | √ | × | × | |
| | Vegetables | √ | × | × | |
| | Combinable & animal feed crops | √ | √ ¹⁰ | × | |
| | Grassland & forage - Harvested | √ | √ ¹⁰ | × | |
| | Grassland & forage - Grazed | √ | × | × | |
| Horticulture^{4,5,7} | Professional | Growing media / growing media constituent | √ | × | × |
| | | Soil improver | √ | √ ¹⁰ | × |
| | Amateur⁷ | Growing media / growing media constituent | √ | × | × |
| | | Soil improver | √ | × | × |
| Forestry/ silviculture⁵ | Tree nursery ⁴ | √ | √ | × | |
| | Tree planting | √ | √ | × | |
| | Established trees | √ | √ | × | |
| | Biomass for energy | √ | √ | × | |
| Land restoration to⁵ | Amenity / public access ⁴ | √ | √ ¹⁰ | × | |
| | Agriculture ⁴ | √ | √ | × | |
| | Forestry | √ | √ | × | |
| Landfill | Landfill as biodegradable waste ⁸ | √ | √ | √ | |
| | Landfill as non-biodegradable waste ⁹ | √ | √ | √ | |
| | Daily or intermediate cover | √ | √ | √ | |
| | Restoration after capping ⁵ | see "Land restoration" | | | |
| Incineration | | √ | √ | √ | |
| Other⁵ | Livestock bedding ⁴ | √ | × | × | |
| | Topsoil manufacture ⁴ | √ | √ ¹⁰ | × | |
| | Biofilter | √ | √ | × | |
| | Organomineral fertiliser ⁴ | √ | √ | × | |

¹ Biological risk has been reduced to 'ambient' levels, e.g. E. coli <1000 cfu/g dry solids

² For 'General purpose' there is some residual biological risk after composting, which necessitates sanitary restrictions

³ Land use restrictions apply to the cropping year of application only

⁴ There is a low tolerance of physical contaminants that might cause traumatic injury (e.g. skin puncture) and/or that might cause aesthetic nuisance

⁵ Chemical contaminants should not exceed safety thresholds evaluated by multiple pathway risk assessment

⁶ Excessive maturity can be a disadvantage for some uses. A degree of microbial activity is essential for disease suppression.

Significant biodegradability (but avoiding phytotoxic risk) is desirable for soil improvement.

⁷ Maturity is essential for growing media and for all bagged products but not for bulk supplies of soil improver (or biological activity suspended by low water activity [<0.65] for bagged soil improver).

⁸ A high degree of sanitisation is desirable for products supplied to amateur users, but also not the context that gardeners use animal manures of uncertain processing history, albeit at pathogen risk.

⁹ The differentiation between biodegradable and non-biodegradable will be stability measurement using a defined method (e.g. ISO 14855:1999 or AT₄ $\leq 5\text{mgO}_2/\text{gVS.h}$)

¹⁰ Grade A standard for 'contras' applies

3.9 BSI PAS 100- The Compost Standard

BSI PAS 100 specifies the minimum requirements for the process of composting, the differentiation and selection of input materials, and the quality of the end product, as well as for the marking and information labelling of the product. (BSI 2003)

The PAS only covers biodegradable materials that have been separately collected from non-biodegradable, or that have not by other means been mixed, combined or contaminated with other potentially polluting wastes, products or materials. It does not give requirements for the selection and differentiation of input materials for composting.

The PAS is not intended to apply to biodegradable materials that have undergone a biological treatment process prior to being land filled, and does not extend to end products of home composting for self-use. It does cover composted materials produced on-farm or at community composting facilities and subsequently used by or on behalf of the producer.

The PAS provides requirements for the minimum quality for composted materials and information about the materials for users and specifiers. This minimum represents limitation of any risk to humans, animals, plants and the environment to acceptable levels during normal usage. It is recognized that those involved in compost production, specification, supply and use may need to know product characteristics associated with further technical parameters and/or require a product of a quality higher than the minimum specified in this PAS.

BSI PAS 100 provides the minimum requirements for composts produced from green waste and catering wastes. It does not recognise that materials such as organic residues produced by a Mechanical Biological Treatment system and which have been processed through a “composting system” are considered to be “Compost”

3.9.1 Certification to BSI PAS 100

In August 2003 The Composting Association reported that over 50% of the UK’s high quality compost is now being assessed for certification by the Composting Association, with the number of compost producers joining the scheme more than trebling since April 2002. (See Appendix D).

Together, the 21 compost producers currently on the scheme have applied for certification of 27 composting processes and 40 composts. This represents nearly 430,000 tonnes of processing capacity per annum – about 51% of the estimated UK total for high value applications in markets such as amateur and professional horticulture, soft landscaping and grounds maintenance.

3.9.2 Testing of composts to BSI PAS 100.

Compost produced from the facility will need to be regularly tested to establish product quality and to conform the requirements of the compost standard. Costs for

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the full range of tests required are between £350-£400 per sample batch from Direct Laboratories and from WRc-NSF a comparative cost £700-£750 was reported²⁰.

²⁰ Personal communications with Ovens R3 Environmental Technology, October 2003

4. Regulations affecting the project.

4.1 Regulatory outline

The Markham Willows facility will fall under a number of regulatory regimes, which cover a diverse range of activities. These include

- Planning Permission.
- Waste management licensing
- Animal By-Product Order (if the site takes Category 3 or catering waste)
- Nitrate Vulnerable Zones Restrictions
- Health and Safety

4.1.1 Planning Permission

As a general rule planning applications will always be required for a composting operation where waste materials are brought onto a site via the public highways for treatment and the operation exceeds 28 days in any one year. A composting site will also be a waste management site.

4.1.2 Waste Management Licensing

There is a legal requirement to obtain a waste management licence from the Environment Agency to carry out commercial composting operations. Waste Management Licensing requires the holder of the licence to put a number of important provisions in place. These include competent person, financial provision and duty of care.

Competent Person: A competent person allocated to the site that is an employee in possession of a Certificate of Technical Competence (COTC) issued by the Waste Management Industry Advisory and Training Board (WAMITAB).

Financial Provision: The site owners have to provide suitable evidence of their financial stability and may be required to post a bond in order to support site clean-up and security in the event of a business failure.

Duty of Care: Duty of Care applies to anyone who produces, imports, keeps, stores, transports, treats or disposes of waste. An operator of a composting facility must therefore comply with the requirements of Duty of Care, which requires the storing of wastes safely and securely, ensuring that a “Waste Transfer Note” is completed whenever wastes are given to, or taken from, someone else and ensuring that wastes are only given to authorised persons or organisations.

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These include: council waste carriers registered waste carriers, exempt waste carriers, holders of waste management licences and so forth.

Currently there is a legal requirement to obtain a waste management licence from the Environment Agency to carry out commercial composting operations. However an exemption may be granted to this licence providing that the site is limited to a maximum of 1,000m³ of material on site at any one time. This equates to a maximum of 400t of shredded green waste.

The UK government is running a consultation exercise (Defra 2003c) to review waste management licences for composting and it is suggested that the exemption rules will be significantly changed.

The Composting Association suggests the following in their recently issued briefing note. (TCA 2003)

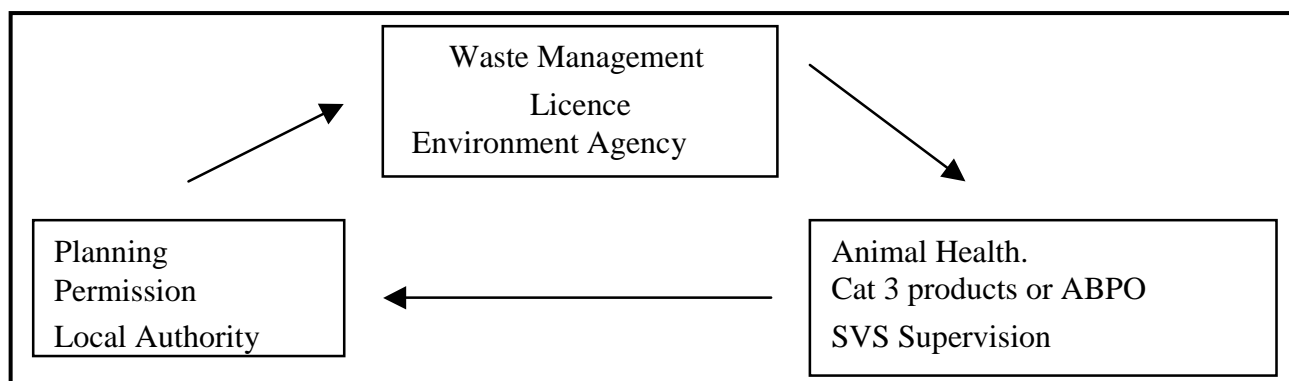
Waste Management Licensing

These conditions are currently under review. Early indications are that the restriction on import and export to/from the composting site will no longer be imposed and that the quantity for exemption will be based on quantities being processed at any one time and based on the facilities available at the site, e.g., 250tonnes being processed at any one time on a very basic farm site, with no hard standing.

Thus, for the requirements envisioned at Markham Willows, a waste management licence will be required before the composting site could become operational at a worthwhile scale. However composting test work may be feasible under an exemption.

The Waste Management Licence which is an integral part of the planning process and dependent on the process and feed stock envisioned for the facility, may require other regulatory bodies such as the State Veterinary Service to be involved. (See Figure 7)

Figure 7 Waste Management Licence links to other regulators



4.2 Review of ABPO

The 2001 the UK discovered an outbreak of foot-and-mouth disease, which started in the North East of England and rapidly spread across the country in what was a major outbreak of the disease. Following amendments to the existing legislation in May 2001 composting of catering wastes and waste which potentially contained meat products were banned. The implication of this ban has had significant impact on the UK composting industry and the efforts of local authorities to meet landfill divergence targets and waste strategy recycling targets.

4.2.1 UK Controls Prior to 1 July 2003

Under the Animal By-Products Order 1999 (as amended) it was an offence to allow livestock (which includes wild birds in its definition) access to catering waste containing meat or products of animal origin, or catering waste which originated from a premises on which meat or products of animal origin were handled. The aim was to prevent the introduction and spread of serious animal diseases such as foot-and-mouth disease that could be in the meat. Although this did not prevent the composting or biogas treatment of catering waste containing meat or products of animal origin, the ban on access by wild birds did, in practice, prevent its use on land (whether treated or not). This effectively banned composting and biogas digestion as treatment and recovery methods for such catering waste.

4.2.2 The new EU rules

The EU Animal By-Products Regulation ((EC) No. 1774/2002) has applied since 1 May 2003, although DEFRA have only been able to enforce it in England since 1 July 2003. It permits the use of composting and biogas treatments for catering waste and other low risk (Category 3) animal by-products. Animal by-products other than catering waste and, until 31 December 2005, some former foodstuffs (Defra 2003) must be treated to at least the EU standard, which is 70°C for 1 hour in a closed system. In addition, high risk (Category 2) animal by-products can be treated to this standard, but only if they have first been pressure rendered to the 133°C/3 bar/20 minute standard.

Category 1 animal by-products such as Specified Risk Material and catering waste from means of international transport are not allowed to be treated at composting or biogas plants under any circumstances. However, for plants which treat only catering waste (and no other animal by-products except for manure, digestive tract content, milk or colostrum), the regulation allows Member States to specify their own standards at national level. To this end, Defra commissioned a risk assessment examining the risks to public and animal health from the use of catering waste in composting and biogas treatment processes. The risk assessment makes recommendations on alternative treatment standards suitable for plants treating only catering waste.

Although Defra had originally proposed to introduce national rules on catering waste via an amendment to the Animal By-Products Order 1999, those rules and the new EU

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rules have now been introduced in England by the Animal By-Products Regulations 2003.

4.2.3 Defra Guide Lines

Defra has produced a document which sets out the guidelines for design and operation of a composting facility which would be capable of successfully treating catering wastes. (Defra 2003) The guidelines set out criteria for the design and operation of composting facilities that would be capable of accepting catering waste or category 3 products. The guide lines do not cover facilities that will process green waste only and as such Markham Willows in its current development would not require approval by the State Veterinary Service.

The Defra guidelines for approved composting or biogas plants provide a number of examples and definitions for

- Catering waste
- Meat excluded catering waste,
- Green waste

Defra Guidance notes, definition of catering waste ‘Catering waste’ is defined under the new EU rules as ‘all waste food including used cooking oil originating in restaurants, catering facilities and kitchens, including central kitchens and household kitchens.’

Defra Guidance notes, definition of “meat excluded” catering waste. ‘Meat-excluded’ catering waste means that measures were taken at source to ensure that meat was not included in the catering waste. In other words, this means that the meat and non-meat fraction of the catering waste must be separately collected, and *never mixed*.

Defra Guidance notes, definition of green waste. Green waste refers to garden or park waste such as grass or flower cuttings, or branches. Waste food from premises on which meat or products of animal origin are not handled (e.g. a dedicated fruiterer).

4.2.4 The effect of the ABPO on composting options

The Animal By-Products Order and the guidance notes effectively enforce the technology and waste sources that can be utilised at Markham Willows. The two allowable approaches will be outside windrowing (single barrier) or “in vessel” followed by secondary windrowing (2-barrier.)

The single barrier approach places heavy emphasis on the facility operator to verify the waste materials accepted by the facility will be appropriately treated and by default, places restrictions on wastes that can be processed. Only green waste or meat excluded catering waste can be processed in a single barrier system.

The 2-barrier in-vessel / subsequent windrowing approach provides security of operation and allows acceptance of a wider range of waste feedstock for the facility.

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One other significant result of adopting the 2-barrier approach will be the ability to impose high gate fees.

4.3 Health and Safety Issues

The Environment Agency, via the Waste Management Licence will take a view of the operations of and working plan for the site and the composting process and will expect to see provision for containment of bio-aerosols, noise, dust and odour (see figure 7).

Figure 8 Extract from the environment agency position on Bio-aerosols at composting facilities. (Environment Agency 2001)

As with any other waste management process composting has the potential to adversely affect the environment and/or human health. In particular, research over the past five years has demonstrated that composting has the potential to produce significant environmental emissions in relation to noise, odours, dust and bio-aerosols (including bacteria and fungal spores). While noise can be adequately controlled through operational measures and dust is reported as unlikely to cause a nuisance to the public, both odour and bio-aerosols have the potential to impact on the public at some distance from the operations. Although they can be reduced they are an inevitable consequence of the natural biodegradation process.

The emissions from waste composting processes have the potential to contain sufficiently high concentrations of bio-aerosols to cause and/or exacerbate certain respiratory disease in some of the population. One cause for concern arises from the thermo-tolerant fungus known as *Aspergillus fumigatus*. Research carried out by DETR and the Agency has shown that concentration levels of the spores of the fungus are likely to be reduced to background levels within a distance of 250 meters from the source. The research also shows that 250 meters is probably sufficient to deal with other releases from a properly operated composting facility such as noise, dust and odour.

4.5 Nitrogen Vulnerable Zones

Defra have increased the number of Nitrate Vulnerable Zones and regulated on the application of nitrogen to grassland and arable farms under the Nitrate Vulnerable Zones program.(Defra 2003d)

The object of the program is to reduce river and watercourse pollution from nitrogen run off and these regulations seek to do this by limiting the application of available nitrogen in specified areas. The Markham Willows site falls into a “Designated Nitrate Vulnerable Zone” under the 2002 designation exercise.

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However, the following information appears to apply to the Markham Willows site and should be confirmed in writing by the regulators. The statement was extracted from the DEFRA web site²¹ “frequently asked questions” section.

When does land that is being restored to agricultural use from landfill, open cast mining etc become agricultural and therefore subject to the Action Programme measures? Is it at the end of the aftercare period or when it enters the aftercare period?

- *Land which is still within its aftercare period following restoration, and being managed according to planning agreements, is not classed as agricultural land even though it may, during this time, be put to an agricultural use. It is not therefore subject to the Action Program measures until the aftercare period is complete.*
- *However, wherever possible application rates of organic N material used for restoration should be within those permitted by the Action Program measures.*

While it would appear from the above that Markham Willows would not be required to comply with the Action Program measures during the restoration phase, it should be noted that application of the finished compost would significantly exceed the 210kg/ha limit imposed by the program.

²¹ www.Defra.gov.uk/environment/water/quality/nitrate/faq-action.htm#70

5. Strategies and costs for composting at Markham

5.1 Current situation at Markham Willows.

In October 2003 DCC estimated the amount of green waste that was likely to be immediately available from the district authorities that make up the North East subarea that is adjacent to the Markham Willows site was in the region of 6,000tpa. Planning permission had also been granted for trial composting operations to take place on the North Tip.

Before the districts would be able to commit to contracting with the Markham Willows facility, the districts would need to be able to demonstrate that composting at Markham Willows would represent best value as a method of cost effective treatment and disposal of green waste, and that the facility was approved by the appropriate regulatory authorities as a fit and proper place for the disposal of waste.

Therefore, for composting at Markham Willows to develop, a number of key specific activities need to take place. These are

1. Making an application for a waste management licence.
2. Designing and tendering for civil works for composting facility.
3. Agreeing contract terms with the districts

The three tasks are interlinked in that the design of the facility will be to some extent reliant on the provisions required by the Environment Agency and until these are identified, final engineering specifications cannot be produced. Final specifications can be included in the formal construction tender enabling the facility gate fee to be established²².

Other supportive tasks (see Table 17) would need to run in parallel to these activities to ensure that the facility would be licensed and available to begin operations in the spring of 2005. The waste management licence would need to be approved prior to final agreement with the districts on gate fee arrangements and following successful conclusion of this exercise, construction contracts could be issued.

Table 17 outlines the main tasks and activities that will need to be carried out to successfully develop the composting facility.

²² Derbyshire have recently been awarded DEFRA funding to establish a household biowaste anaerobic digestion plant. This may mean that the composting facility may need to be re-evaluated to be integrated with the anaerobic digestion facility.

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Table 17 Summary of tasks for Markham Willows Composting Facility Development

| Task | Spring 2004 | Period | Period | Period | Period | Period | Period | Period | Period | Spring 2005 |
|--|-------------|--------|--------|--------|--------|---------|--------|--------|---------|-------------|
| Apply for waste management licence | Task 1 | | | | | | | | | |
| Issue tender for construction works | Task 2 | | | | | | | | | |
| Receive tenders for construction | | Task 3 | | | | | | | | |
| Update business models | | | Task 4 | | | | | | | |
| Receive confirmation that waste management licence will be granted | | | | Task 5 | | | | | | |
| Confirm contract/ gate fees with districts | | | | | Task 6 | | | | | |
| Issue contracts for construction. | | | | | | Task 7 | | | | |
| Construction underway | | | | | | | Task 8 | | | |
| Construction completed & facility approved | | | | | | | | Task 9 | | |
| Issue tender for equipment or contract service for composting operations | | | | | | Task 10 | | | | |
| Appointment of staff Member with COTC | | | | | | | | | Task 11 | |
| Equipment on site or contract for services signed | | | | | | | | | Task 12 | |
| Facility available to take waste | | | | | | | | | | Task 13 |

Note: - Tasks 1 & 2 are linked, by the requirement to understand the EA site-specific requirements for the Waste Management Licence. Other tasks can run in parallel to the licence application, but cannot be completed until it is issued.

Key point of commitment

5.2 Composting equipment and services for the facility and their costs

Commercial windrow composting is a mechanised process carried out in the open air using industrial equipment. Basic operations are movement and shredding of green waste, formation of windrows with shredded green waste, turning and movement of windrows, screening of finished compost for size separation, out loading of compost to final designation.

The equipment required to carry out these tasks is driven by the throughput of the facility and is sensitive to seasonal swings in demand.

Appendix B:- Chart 3, Typical variations in green waste procurement. shows typical input tonnage variations for green waste.²³ This data is used to determine the theoretical machine availability achieved in processing predicted waste inputs for Markham Willows. At the relatively low input waste tonnage predicted for Markham Willows, significant overcapacity can be expected in dedicated equipment. Appendix B chart 1, shows the resulting calculations for equipment use and appendix B chart 2, is used to calculate the cost of hire equipment required.

It is generally uneconomic to build low capacity machines, which have the durability and reliability required for industrial use, most manufactures build for a capacity that will far exceed the requirements of the Markham Willows composting facility.

One option is to share use of compatible equipment with other areas of the MEGZ development. Table 18 indicates where equipment is compatible for use in other areas of the MEGZ development. There are some advantages to be gained in sharing equipment with other departments, assuming that a satisfactory mechanism can be developed for the internal transfer of costs. However not all of the composting equipment can be utilised in other areas such as SRC harvesting or grounds maintenance and in the initial stages of the composting operations and development and subcontracting the service may be the most economic and effective process.

²³ Input data used is typical of commercial composting operations. Data provided by SITA.

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Table 18 Use of equipment at Markham

| Equipment | New & second hand Costs | Markham Willows composting use | MEGZ use/ DCC use | Benefits and problems |
|---|---|---|---|--|
| JCB 530-70 Tele hoist | New £30,000 S/hand £20,000- £25,000 | Loading of shredder, windrow building, windrow turning, and bulk out-loading. | Estate maintenance, road sweeping (with attachment). Access platform to 7m (lights, low gutters etc). Fork lift / light crane capability. | Maximise use of machine, but potential conflicts of use in periods of maximum use. May incur heavy maintenance costs. Not suited to windrow turning and may produce an inferior compost product. |
| JCB 436 Front End Loader | New £80-85,000 | Loading of shredder, windrow building, windrow turning, and bulk out-loading. | Few uses for estate maintenance, other than heavy snowfall clearance. | Machine is capable of heavy-duty use and would be able to respond to surges in demand. However it is too big to have any practical use in estate maintenance. |
| Green waste shredder Jenz AZ-35-120-D | New £100,000 S'hand £40- £50,000 | Shredding of green waste. | Shredding of green waste, parks and garden waste, tree pruning, etc. | Machine capable of being easily moved by road. With minor changes to configuration of the machine it can be used for chipping the SRC and other clean woods to a specification suitable for wood fuel use. |
| Windrow turner Doppstadt | New £175,000 | Purpose built machine for turning and mixing compost. | No other use. | Large capital cost, inefficiently used if not fully utilised. |
| Compost Screen Doppstadt (New) Farwick (S/hand) | New £75,000 S/hand £30- £40,000 | Size separation of finished compost. | No other practical use. | Large capital cost, inefficiently used if not fully utilised. |

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Subcontracting and hire of composting equipment is an established practice with contractors providing suitable, usually high capacity equipment for hire at day and weekly rates. Appendix B:-Chart 4, Typical machine costs, is a breakdown of new and second-hand composting equipment. It also provides information on equipment and service costing for contracting out the shredding, windrow turning and screening activities.

This information has been condensed into six options shown in Table 20, which consider the cost effect of purchasing, new, second hand, and contracted services at the expected starting input tonnage.

From this exercise it can be seen that at 6,000tpa input,

- Option 1 offers the lowest cost recovery by using new and second hand machines, but also offers a marginal technical solution.²⁴
- Option 2 use all new machines, purchased. The use of a JCB 535-70 tele hoist for most of the operations may incur heavy maintenance costs and hence it is a marginal solution.
- Option 3 uses all new machines, purchased, but with a more robust Front End Loader The use of the JCB 436 enables a robust technical solution for windrow turning
- Option 4 offers the second lowest cost option by utilising a combination of contract hire and spot hire for equipment using a JCB 535-70 tele hoist, but also offers a marginal technical solution.
- Option 5 shows reduced recovery rates required over a 3-year period if the JCB 535-70 is purchased.
- Option 6 shows slightly higher cost for contract hire than Option 4, but use of a JCB 436 would provide a more robust mechanical solution.

The six options model a feasible range of scenarios for the composting facility and based on the suggested initial input tonnage of 6,000tpa repeated over a three year period, delivers costs ranging from a low of £5 per tonne input for Option 1 through £6-£10 per tonne for Options 4,5, & 6 with Options 2 & 3 at £11 & £14 per tonne input. Increased throughput at the facility to the design level of 10,000tpa input improves the costs effectiveness for all six options. Procurement options ranked by cost are illustrated in Table 19.

²⁴ A “marginal or robust technical solution” is an indication of the equipments selection in terms of its availaibility for operation and considers factors such as maintenance. Thus a “marginal technical solution” exists if the equipment is undersized for its duty, but offers a cost effective solution in relation to general operating costs and conversely, a “robust technical solution” would offer an oversized machine capable of significant operational flexibility.

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Table 19 Equipment procurement options graded in terms of minimum to maximum direct cost recovery²⁵

| Direct cost recovery option Lowest cost (A) to highest cost (F). | A | B | C | D | E | F |
|---|----------|----------|----------|----------|----------|----------|
| Procurement Option Number | 1 | 4 | 5 | 6 | 2 | 3 |
| Direct recovery cost | £5.00 | £6.90 | £9.56 | £10.17 | £11.40 | £14.12 |

Table 20 Equipment cost options

| Option 1 Lowest cost purchase using new and second hand | Cost | Recovery cost per tonne input year 1 | Recovery cost per tonne input over 3 years |
|---|----------------|---|---|
| Loading and windrow building by JCB 535-70 tele hoist (New) | 30,000 | 5.00 | 1.67 |
| Jennz shredder for green waste shredding (S/hand) | 40,000 | 6.67 | 2.22 |
| Windrow turning using the same JCB 535-70 tele hoist | 0.00 | 0.00 | 0.00 |
| Screening using second hand screen (s/hand) | 20,000 | 3.33 | 1.11 |
| Bulk out-loading using same JCB 535-70 tele hoist | 0.00 | 0.00 | 0.00 |
| | 90,000 | 15.00 | 5.00 |
| Option 2 Purchase using all new equipment. (Marginal Equipment Solution) | Cost | Recovery cost per tonne input year 1 | Recovery cost per tonne input over 3 years |
| Loading and windrow building by JCB 535-70 tele-hoist (New) | 30,000 | 5.00 | 1.67 |
| Jennz shredder for green waste shredding (New) | 100,000 | 16.67 | 5.56 |
| Windrow turning using the same JCB 535-70 tele hoist | 0 | 0.00 | 0.00 |
| Screening using Doppstadt screen (New) | 75,000 | 12.50 | 4.17 |
| Bulk out-loading using same JCB 535-70 tele-hoist | 0 | 0.00 | 0.00 |
| | 205,000 | 34.17 | 11.40 |
| Option 3 Purchase using all new equipment with JCB 436 front end loader instead of tele hoist (Robust equipment solution) | Cost | Recovery cost per tonne input year 1 | Recovery cost per tonne input over 3 years |
| Loading and windrow building by JCB 436 FEL (New) | 79,000 | 13.17 | 4.39 |
| Jennz shredder for green waste shredding (New) | 100,000 | 16.67 | 5.56 |
| Windrow turning using the same JCB 436 FEL | 0 | 0.00 | 0.00 |
| Screening using Doppstadt screen (New) | 75,000 | 12.50 | 4.17 |
| Bulk out-loading using same JCB 436 FEL | 0 | 0.00 | 0.00 |
| | 254,000 | 42.34 | 14.12 |

²⁵ “Direct cost recovery” is a basic indication of cost effectiveness. It is derived by calculating the total capital investment cost or hire charge cost for the composting mobile plant, and dividing by the total tonnage of waste input over a period (in this case 3 years). The result gives an initial indication of viability. There are six options using different combinations of procurement.

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| Option 4 Hire of shredder and screen, contract hire of JCB tele-hoist. | Cost | Recovery cost per tonne input year 1 | Recovery cost per tonne input over 3 years |
|---|----------------|---|---|
| Loading and windrow building by JCB 530-70 (Contract Hire) | 10,400 | 1.73 | 1.73 |
| Hire Shredder (costs per year for day hire) | 22,000 | 3.67 | 3.67 |
| Windrow turning using the same JCB 530 tele hoist | 0 | 0.00 | 0.00 |
| Hire Screen (costs per year) | 9,000 | 1.50 | 1.50 |
| Bulk out-loading using same JCB 530 tele hoist | 0 | 0.00 | 0.00 |
| | 41,400 | 6.90 | 6.90 |
| | | | |
| Option 5 Hire of shredder and screen, purchase of JCB 436 FEL | Cost | Recovery cost per tonne input year 1 | Recovery cost per tonne input over 3 years |
| Loading and windrow building by JCB 436 FEL (New) | 79,000 | 13.17 | 4.39 |
| Hire Shredder (costs per year) | 22,000 | 3.67 | 3.67 |
| Windrow turning using the same JCB 436 | 0 | 0.00 | 0.00 |
| Hire Screen (costs per year) | 9,000 | 1.50 | 1.50 |
| Bulk out-loading using same JCB 436 | 0 | 0.00 | 0.00 |
| | 110,000 | 18.34 | 9.56 |
| | | | |
| Option 6 Hire of shredder and screen, Contract hire of JCB 436 FEL | Cost | Recovery cost per tonne input year 1 | Recovery cost per tonne input over 3 years |
| Loading and windrow building by JCB 436 FEL (New) | 30,000 | 5.00 | 5.00 |
| Hire Shredder (costs per year) | 22,000 | 3.67 | 3.67 |
| Windrow turning using the same JCB 436 | 0 | 0.00 | 0.00 |
| Hire Screen (costs per year) | 9,000 | 1.50 | 1.50 |
| Bulk out-loading using same JCB 436 | 0 | 0.00 | 0.00 |
| | 61,000 | 10.17 | 10.17 |

The “direct recovery cost” is the actual amount that needs to be recovered from the operating revenue of the facility relative to its throughput. It is not an operating cost and does not take into consideration, fuel labour, depreciation etc. The direct recovery cost serves as an indication of the most cost effective route to procurer the machines and services for the facility. This exercise indicates that careful consideration must be paid to the procurement of services and equipment for the facility, if its use is to be cost effective. While there is some scope for sharing of equipment for estate maintenance (see Table 18) on the MEGZ development, most of the equipment will not be suitable for use at the small scale that estate maintenance requires.

5.3 Composting facility establishment and construction costs

The facility design is based on 10,000m² hot-rolled asphalt hard-standing on which all-composting operations are carried out. The entire hard standing is drained to a suitable storage lagoon for the capture of run off water and leachate. Pumps are provided to enable stored run off water and leachate to be used to provide moisture for the composting process if required. Buildings for staff accommodation and equipment maintenance are provided. The accommodation, delivery and shredding areas will be provided with a security fence. Road access is provided for delivery and despatch of materials.

Table 21 Costs for civil works construction at Markham Willows for 10,000tpy facility²⁶

| Item | Description | Quantity | Rate | Amount |
|------|---|----------------------|---------|-------------|
| | <i>Hard standing for input materials and shredded materials</i> | | | |
| 1 | Earthworks to prepare sub base, assume re-grade of area | 10,000m ² | £1.50 | £15,000 |
| 2 | 250mm thick sub base | 9,500m ² | £7.50 | £71,250 |
| 3 | 40mm wearing course and 100mm base course Hot Rolled Asphalt | 9,500m ² | £18.25 | £173,375 |
| 4 | Geotxitle membrane | 9500m ² | £0.70 | £6,650 |
| | <i>Drainage</i> | | | |
| 5 | Install channel drainage to slab area to two sides and at 10m centres | 1,000m | £25.00 | £25,000 |
| 6 | Form gullies for discharge | 10 off | £225 | £2,250 |
| 7 | 150mm pipe work to lagoon | 50m | £15.25 | £762.50 |
| 8 | 300mm carrier drain | 100m | £32.75 | £3,275 |
| | <i>Form Lagoon</i> | | | |
| 9 | Excavate and deposit on site | 2,500m ³ | £1.75 | £4,375 |
| 10 | Line with HDPE | 1,250m ² | £7.50 | £9,375 |
| 11 | Headwall to lagoon | 1 off | £1,500 | £1,500 |
| 12 | Re-circulating pumps and floats | 1 off | £7,500 | £7,500 |
| | <i>Amenity Block</i> | | | |
| 13 | Portacabin, 30ft x 10ft provision sum | 2 off | £5,500 | £11,000 |
| | Plant maintenance shed | | | |
| 14 | Provisional sum | 1 off | £15,000 | £15,000 |
| 15 | Provisional sum for service connections | 1 off | £5,000 | £5,000 |
| | <i>Fencing, roads and access</i> | | | |
| 16 | Chain link fence processing areas | 500m | £24.50 | £12,250 |
| 17 | Gates | 2 | £1,500 | £3,000 |
| 18 | Access road, 100m x 8m wide | 800m ² | £ 26.45 | £21,160 |
| 19 | Preliminaries | 6 weeks | £3,750 | £22,500 |
| | Project total | | | £410,222.50 |

²⁶ Cost data provided by VHE plc.

5.4 Overview of main composting cost drivers

The establishment of indicative costs for the Markham Willows composting facility is a project specific task. Reference to recent authoritative reports including the recent “Costs for municipal waste management in the EU” (Hogg 2002) can provide indications of costs for composting operations throughout Europe, however it is difficult to achieve direct comparisons with all aspects of the Markham Willows project within the case studies reviewed. Consequently, only costs, which have been sourced specifically for the Markham Willows project have been used.

The Markham Willows composting facility will incur costs at both its construction and operations phases. Table 22 shows the broad areas in which expenditure will be required.

Table 22 Main cost elements for Markham Willows.

| Cost centre or element | Description | Cost impact and comment |
|----------------------------------|---|--|
| Site and physical infrastructure | Roads, fencing, hard standing, drains, lagoons, landscaping, weighbridge and office/ mess rooms | Significant initial cost required establishing the facility, with ongoing maintenance |
| Compost processing equipment | Front end loader, shredder, Screen, windrow turner | Many options available from outright purchase to contracting in the services required. Option chosen depends on funding available and green waste input tonnage |
| Operational labour and support | At least two staff allocated | Waste management licence will require COTC ²⁷ staff member allocated to site. Costs may be shared across other duties dependant on facility loading |
| Testing and compliance | Testing of compost produced for accreditation of facility | Facility to strive to be an accredited compost producer producing compost to the British standard PAS 100. Will require inspection and regular testing of its output compost |
| Waste Management licence | WML Required to operate the facility. | Initial application fee and ongoing annual charges for compliance |

Provisional costs for a typical composting facility were obtained based on a composting capacity of 10,000tpa. Table 21 indicates the civil engineering and building costs estimated for the hard standing and lagoons, drainage roads and buildings. These costs can be categorised as capital expenditure costs. Other costs such as labour, compost testing and regulatory charges are mainly operational in

²⁷ Certificate of technical competence issued by WAMITAB

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nature, however the mobile plant and equipment that is used in the composting process is a significant factor in overall cost and profitability of the facility.

5.5 Composted Products

The short rotation coppice plantations would be the main user of the output of the composting facility. It became apparent in the project planning stages that the composting facility would not be operational before late spring- early summer of 2005, mainly owing to the need to apply for the waste management licence and the need to have possession of the licence prior to entering into a construction contract. However planting of the first plot of willow is planned for the spring of 2004.

Following the establishment of the four willow plots, there is likely to be a surplus of compost available for sale. It is envisioned that these materials would be available to the districts and county for use in ground keeping and estate maintenance activities. Alternative markets for compost were also identified such as the APEX marketing project²⁸, which purchases bulk quantities of compost for retail sale. Typically green waste composting facility's can produce compost to the British Standard PAS 100, which would enable widespread use depending on available markets, although compost prices per tonne do tend to be low in monetary terms.

The compost required for use at the Markham Willows SRC plots will be graded by size to give a larger percentage of "oversize" material with the likely size range to be >25mm to <75mm, but with the size fraction biased towards the finer end of the scale. The use of the coarser fraction of the compost helps to provide voidage within the formed soil, assisting with the provision and circulation of oxygen.

Composts produced for off site sale would be graded to suit the available market and may well produce a proportion of oversize materials, which would require further treatment or disposal. Compost produced for sale would need to be manufactured to meet the standards set out in BSI PAS 100.

5.6 Compost use for short rotation coppice

Current master planning envisions a total plantation of 60 ha, planted annually in 15 ha plots. For each 15 ha SRC plots there will be an initial period of several months for soil formation and willow planting. A first cutback follows after 12 months. There is a further 20-24 month growth period prior to harvesting giving a 3-year first cycle. After the first harvest, each plot will then be harvested at 3 or 4-yearly intervals. The first plot will be established in the spring of 2004 and subsequent planting will take place in the spring of 2005, 06, & 07.

Both the soil formation and cultivation stages will use compost. The soil formation stage is based on the addition of sewage sludge and compost (pot trials carried out by AEA indicate that the combination is better than using either material alone). Cultivation uses compost as mulch applied after first cutback and after harvest.

²⁸ <http://www.apexcompost.co.uk/>

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During soil forming organic matter is applied to the surface to be planted. This is then mixed into the top 15 cm of the surface using a disc cultivator. The maximum depth that can readily be disced in on the surface of the North Tip is 10 cm²⁹. It is assumed a 50/50 mixture of sewage sludge³⁰ and compost is applied, as this will be the simplest mixture to manage on site. To allow some leeway, the application depth to be used is 8 cm, hence the depth of compost added will be 4 cm.

Hence, each plot has an establishment phase and then moves to regular harvesting routine, consisting of the following

1. Soil forming. The incorporation into the surface of the colliery spoil of sewage sludge and compost in a 50/50 mixture to establish a suitable soil for planting willow.
2. Cutback. Approximately 12 months after planting, the willow is cut down to approximately 6 cm height that promotes rapid re-growth. Compost is applied as a mulch to a depth of 4 cm immediately after cutback occurs.
3. Harvest. After a further 3 years, the first harvest takes place and on completion of the harvest, an application of compost as a mulch at 4 cm depth is made.
4. Each plot is then allowed to grow for 4 years when it is harvested again and a further application of a compost mulch can be made.

4 cm depth of compost and 4cm depth of sewage sludge will equate to approximately 3,000 tonnes of compost (assuming a bulk density of 500 kg.m³) and 6,000 t of sewage sludge (assuming a bulk density of 1000kg/m³) for each 15ha plot.

Mulching is based on an application of 4 cm depth of compost, which will equate to 3,000 tonnes per application. These depths of composts represent relatively small additions, and greater volumes could be added.

On site compost production at Markham Willows is likely to begin, at the earliest by mid 2005 following the granting of the waste management licence and completion of construction of the facility³¹. With a process time of 3-4 months, no significant amount of compost is expected from the Markham Willows facility during 2005. Modelling for compost delivery only considers production of a yearly basis and therefore the compost produced from waste input in 2005 is only considered available for use in 2006.

To enable more precise predictions to be made on the relationship between waste input, compost production, compost requirements and the need to import compost, modelling would need to be carried out on a more detailed basis, most probably by looking at the needs and requirements on a quarterly basis. Modelling at this level would also allow seasonal variations in deliveries to be incorporated.

²⁹ Coppice Resources Limited, Personal Communication.

³⁰ Sewage sludge will be provided free of charge by Severn Trent from a local treatment works

³¹ DCC indicated that this would be their expected timescale for the development.

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Figure 9 illustrates the production and use of compost at the Markham Willows project over time, based on the following assumptions and projections.

The projection assumes an increase in green waste input over a 4-year period taking the facility up to its full capacity. The increase in waste is assumed to come from household participation in source separation and collection services for green waste and use of the facility by private contractors such as landscape gardeners. Table 23 shows the assumed projection for an increase in input tonnage.

Table 23 Predicted input tonnage for Markham Willows

| | | | | | |
|---------------|------|-------|-------|-------|--------|
| Year | 2005 | 2006 | 2007 | 2008 | 2009 |
| % Increase | | 10% | 15% | 15% | 15% |
| Input Tonnage | 6000 | 6,600 | 7,950 | 8,728 | 10,037 |

During the composting process, there is an overall mass loss (loss of tonnage), which is the result of moisture loss and biological degradation. A nominal reduction of 30 % is used to demonstrate this effect for modelling purposes, which in actual composting operations can be in the range of 25%-40% dependant on the composting regime, seasonal and atmospheric conditions.

The output or finished compost tonnage is also influenced by the size of the materials screened out of the finished compost. Oversize materials, which in most commercial composting operations means >25mm are rejected reducing the finished mass further. The modelling exercise takes this factor into account, allowing for the use of a greater amount of oversize, which is considered to be beneficial in the production of compost for mulching applications.

Thus for the input tonnage predicted in Table 23, the model predicts finished compost tonnage will be as shown in Table 24.

Table 24 Comparison of Input and finished compost tonnage

| | | | | | |
|------------------|-------|-------|-------|-------|--------|
| Input tonnage | 6,000 | 6,600 | 7,590 | 8,728 | 10,037 |
| Finished compost | 4,200 | 4,620 | 5,313 | 6,109 | 7,026 |

There is a significant processing time to be considered which is generally between 3-4 months from delivery of waste into the facility to finished compost being delivered. The input tonnage to finished compost relationship is also affected by seasonal delivery variations and climatic conditions. Therefore the model assumes that finished compost received in year X will be stockpiled for use in Year Y. Table 25 shows the modelled output for finished compost, based on the projected input tonnage

In practice it is likely that compost would be stockpiled until required for use. The SRC plots will be harvested in late autumn or early spring depending on the ground conditions and an application of compost will be made on the completion of harvest.

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Suitable contractors will most probably carry out the actual application of compost in one operation and this would also require that a sufficient stock of compost is available to ensure a cost effective operation.

Table 25 Modelling predictions for finished compost from the Markham Willows facility

| Year | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|----------------------------|------|-------|-------|-------|-------|-------|
| Finished compost available | 0 | 4,200 | 4,620 | 5,313 | 6,109 | 7,026 |

Willow planting will therefore require compost to be imported to the site, particularly during the soil forming stages, which coincides with the development, and build up of production of the Markham Willows facility. With the first plot due to begin soil forming operations in the spring of 2004, and the remaining three plots in subsequent years, compost will be required for soil formation and mulching.

Table 26 indicates the SRC requirements for compost.

Table 26 SRC soil formation and mulching requirements for compost³²

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---------------------|-------|-------|-------|-------|-------|-------|-------|
| Compost requirement | 3,000 | 6,000 | 6,000 | 9,000 | 6,000 | 3,000 | 3,000 |

Table 27 indicates the predicted requirements for imported compost. By cross-referencing with Table 25 and, Table 26 the net compost requirement can be derived.³³

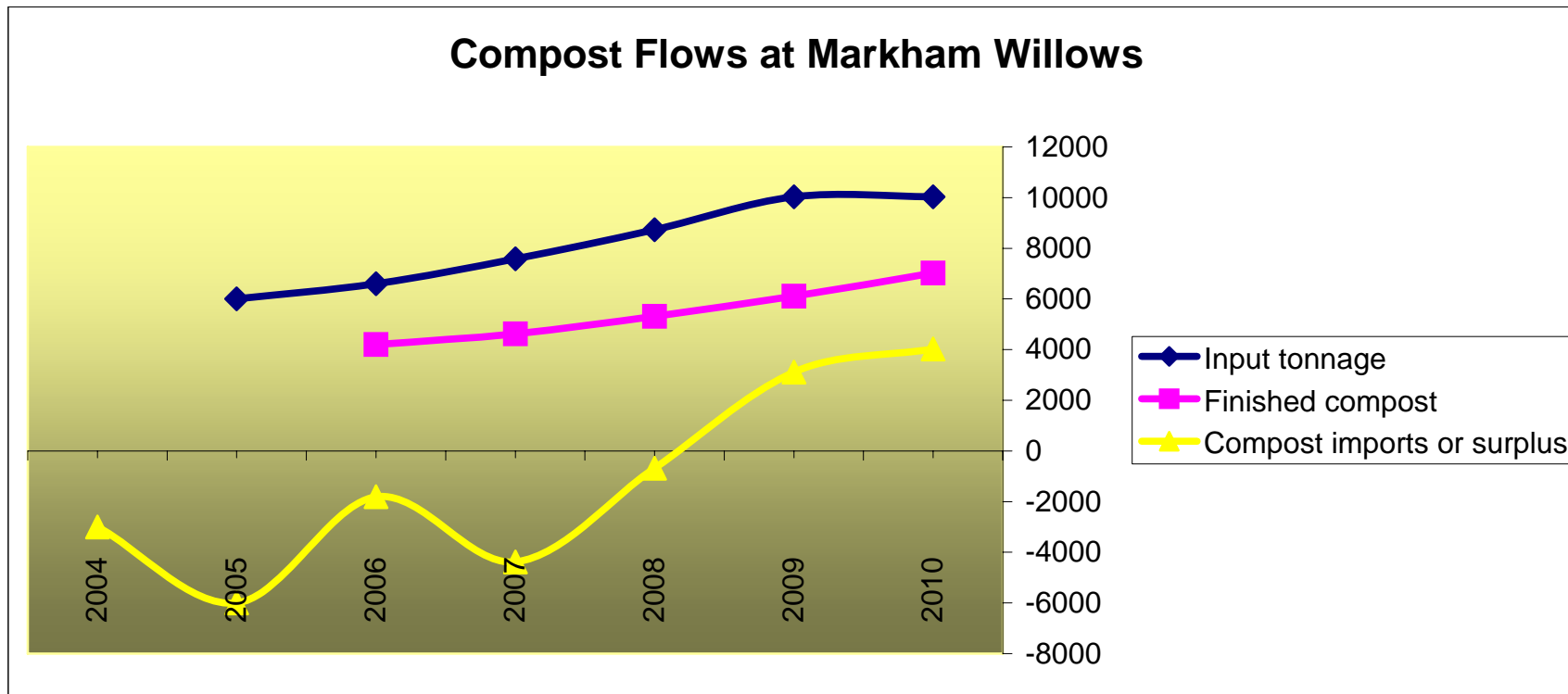
Table 27 Compost import requirements

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|--------------------------------------|-------|-------|-------|-------|-------|-------|-------|
| Compost required (Table 26) | 3,000 | 6,000 | 6,000 | 9,000 | 6,000 | 3,000 | 3,000 |
| Compost available from MW (Table 25) | 0 | 0 | 4,200 | 4,620 | 5,313 | 6,109 | 7,026 |
| Imported | 3000 | 6,000 | 1,800 | 4,380 | 687 | | |
| Surplus | | | | | | 3,110 | 4,026 |

³² Predictions are based on year by year modelling; more precise prediction will require a more detailed model based on quarterly prediction and not 12month predictions.

³³ The full model can be accessed via R3 Environmental Technology Ltd.

Figure 9 Compost flows during SRC establishment



Note that values shown are total tonnage of materials required or produced at year end.

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The variations in the requirement to import compost are due to the staggered planting of the 15 ha plots coinciding with cutback and harvesting applications. By 2008 all plots are planted and the requirement for compost reduces to an application to each plot after it has been harvested. The plots will be harvested every 4 years after the initial harvest and a post harvest application of 4cm of compost results in a compost requirement for 3,000tpa.

From 2009 the Markham Willows facility will produce surplus compost, which can be utilised in either deeper applications of compost or will be available for use or sale.

The current timescales and modelling predictions indicate that approximately 15, 800 tonnes of compost would need to be imported over the period 2004 to 2008 if compost is used in conjunction with sewage sludge in the soil forming exercise on all four 15ha plots.

The demand for imported compost can be reduced by the increased use of sewage sludge or the reduction of compost in the soil forming stage. Sewage sludge is not considered suitable for the mulching applications following soil forming.

Increased waste input to the facility would also reduce the need to import compost, but as imported compost is required for the SRC establishment, which occurs between 2004 and 2008, additional waste procurement beyond the 6,000t predicted to be available may be difficult in the short term. Table 28 sets out the predicted amounts of compost that would be required over the period of 2004 to 2008 which are the soil forming and SRC establishment stages. The table indicate the import requirement when a 50/50 sewage sludge –compost mixture is used in soil forming versus sewage sludge only. In the latter case, compost imports are used for mulching.

Table 28 Variations to requirements for imported compost

| Year | 2004 | 2005 | 2006 | 2007 | 2008 | Totals |
|---|-------|-------|-------------------|-------|------|--------|
| Soil forming with sewage sludge and compost | 3,000 | 6,000 | 1,800 | 4,380 | 687 | 15,867 |
| Soil forming with sewage sludge only | 0 | 3,000 | (1,200) Note * | 1,380 | 687 | 3,862 |

* First compost from the Markham Willows composting facility becomes available providing a surplus of compost that is carried forward to reduce the overall tonnage of imported compost required in this scenario. All other predictions include the output from the Markham Willows composting facility. The compost-produced from Markham Willows may have two uses.<10mm compost can be sold in bulk to organisations such as APEX or other local users such as the MEGZ development for use in its grounds maintenance activities. The oversize may be used for mulching activities either for the SRC plots or for the MEGZ development.

SRC mulching can use a courser fraction of compost, which can be up to <75mm. This enables the smaller size fraction to be diverted for use elsewhere if required or sold in bulk to APEX or other organisations. This would be a management decision based on the several factors such as waste availaibility, SRC requirements for compost and prospective sale value of compost.

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As shown in Table 27, on completion of the establishment of the SRC and the transition to the regular harvesting routine, there will be a surplus of compost available for use or sale. If the waste input to the Markham Willows composting facility does not rise above its predicted 6,000tpa, approximately 1,000tpa will be available. However if the facility is fully utilised at its design capacity of 10,000tpa, some 4,000 tpa of compost will be available for use in other applications.

It will be important management issue to find a cost effective disposal route for this low value material. The Markham Willows facility derives its main source of income from a gate fee rather than compost sales and so must continue to process compost. While there is probably scope for additional use of composts on the Markham Willows site in increased compost application depth following SRC harvest, this would probably not deal with all of the available compost³⁴.

5.7 Markets for surplus composts not required for SRC.

The potential markets for the compost produced at Markham Willows will be entirely dependant on the quality of the compost produced. Using green waste as an input material and with good process controls, compost, which achieves the requirements of BIS PAS100, should be the target output of the facility. The research carried out by WRAP indicates that there are alternative markets for lower grade composts, but these may have very little or zero value. Finished compost, which is not required for use on the SRC, can be used in the following areas.

- Soil establishment purposes in other areas of the spoil tips
- Mulch for DCC parks and gardens
- Bagged for public sale
- Provided free to the local community.
- Sold in bulk to APEX.
- Grounds Maintenance for the MEGZ development.

Soil establishment purposes in other areas of the spoil tips

VHE plc report costs for mulches derived from “recycling”³⁵ (which is assumed to mean composted materials sourced from green waste composting facilities) are priced at between £10-£15/tonne delivered. Compost produced from the Markham Willows facility could be used or blended with other suitable materials to provide a lower cost substitute for use in the MEGZ development and other local remediation projects.

Mulch for DCC parks and gardens

Derbyshire County Council and the District Authorities can make use of composts and mulching materials produced at the Markham Willows. By collecting the materials from the facility directly rather than contracting for the delivery of bulk

³⁴ A doubling of the expected application depth from 4cm to 8cm would require 6,000tonnes per application. This would still leave a surplus of compost even if the 8 cm application depth was viable.

³⁵ Personal communication. Ovens, R3 Environmental Technology.

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supplies, they can avoid transport charges that are the main component of delivered composts and mulches.

Bagged for public sale.

Contractors normally carry out compost bagging. The cost for small quantities can be significant, arising mainly from initial set up costs for the artwork and production of bags. Bagging contractors then visit site and bag up a quantity of material as required. Bagged compost, which would be the finer <10mm fraction of the finished compost could be sold at the facility. It would however, have to compete with sales of compost and “peat free” compost from DIY stores and garden centres.

Provided free to the local community.

Surplus compost could be provided free on a “free if collected” basis. The possible advantages of this approach would be the “ownership” of the materials by the providers of the waste, which complements the understanding of recycling. Provision of free compost to local action groups also will enable Derbyshire County Council to support projects, which require composts and mulches. Typical projects could be woodland creation, and small scale planting of surplus or unused land in suburban settings.

Sold in bulk to APEX.

APEX is a collaboration developed by SITA UK, Onyx, Cleanaway and Freeland Horticulture to manufacture high quality compost to the Apex standard and supply the landscaping and retail market. Projects include Eden project, Canary Wharf, Millennium Village, Bluewater Shopping Centre, Vodafone HQ, British Airways HQ, Rolls Royce and Tag McLaren F1 team. Apex also supplies compost to William Sinclair for use in the J Arthur Bowers organic soil improver distributed to B&Q, Homebase, Wyevale and independent garden centres.³⁶

Compost sold to Apex or bagged on site by contractor will be generally of smaller size fraction with the requirement for the fine fraction to be included, but oversize excluded. The typical size range for bagged compost will be 1-<30mm Composts produced from green wastes will increasingly be required to be produced to a consistent standard and quality required to meet standards required by BSI PAS-100 as demonstrated by the increase in compost producers gaining The Composting Association accreditation. (See Appendix D

Producing composts, which achieve APEX or PAS100 standards, may represent the easiest route to market as the APEX initiative is already marketing compost widely and has capacity to take on further suppliers. Apex can also provide an outlet for lower grade composts through supplies to agriculture.

Grounds Maintenance for the MEGZ

³⁶ Apex information extracted from the SITA web site, January 2004.

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There will be an initial and ongoing demand for mulching materials and compost for the MEGZ development. By using materials sourced from the Markham Willows facility, transport costs which form a significant part of the cost of delivered composts could be avoided, offering significant savings to the development and for ongoing maintenance.

Processing of compost to PAS 100 standards.

All compost produced at the site should be produced to the applicable BSI PAS100 standard. This will ensure that clear guidelines for the operation of the facility are adopted for the facility from day one and thus avoiding the need to change established practices at a later stage in the facilities development. For compost sold to APEX or many other organisations, compliance with BSI PAS 100 would be a pre requisite.

6. Benchmarking and key performance indicators

6.1 Introduction

The Markham Willows facility needs to be judged in its overall effectiveness as an exemplar project and each phase of the project needs to identify criteria against which it may be judged. The key performance indicators (KPI's) seek to identify criteria against which the Markham Willows composting facility can be benchmarked and compared, when judged against other forms of contaminated land remediation, bio-fuel production and treatment of biological waste.

The following Key Performance Indicators have been identified, compost quality, compost rejects, green waste and production of compost as set out in Table 29

Table 29 Key performance Indicators for the Markham Compost facility

| KPI | Benchmark technique and data collection method | Target |
|--|---|---|
| Compost quality | Production to BSI PAS 100 | Full compliance of compost produced for use or sale |
| Compost reject levels | Records and remedial actions | Reducing or acceptable minimum levels of reject compost |
| Diversion of green waste | Weighbridge records and BVPI statistics | Maximise capacity of the facility |
| Cost intensity of composting provision | Cost effectiveness of process | Minimum cost / high integrity composting operation |

6.2 Compost quality

The aim of the facility will be to produce compost which will comply with the specifications required in BSI PAS 100. Notably these are requirements for the minimum quality for composted materials and information about the materials for users and specifiers. BSI PAS 100 seeks to limit any risk to humans, animals, plants and the environment to acceptable levels during normal usage.

Thus the KPI for the facility will be its ability to consistently produce quality composted product using a workable and repeatable system of operation. In order to achieve this consistency a working plan for the site would be developed and the facility would need to work towards achieving The Compost Association accreditation (See Appendix D).

6.3 Levels of rejects

An aspect of the composting process, which can be monitored, are the levels of reject materials produced from the composting operation and the methods used to minimise these levels. In addition to the actual working practices adopted at the facility to

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minimise and reduce reject levels such as stones, large wood, plastics and glass, interaction with the local population and the collection method can be used to try to ensure that only suitable materials are collected.

6.4 Diversion of green waste per capita of catchment area

Derbyshire as a county and as local districts will be required to publish via the Best Value Performance Indicator scheme (BVPI's) information on their recycling and recovery efforts on a yearly basis. Regular updates via a newsletter containing information about of the Markham Willows composting facility may be a way to increase the local population's awareness of the project and possibly increase participation rates.

As an indication of the success of the composting facility, comparing the green waste input per capita against the national and regional average statistics produced by Defra would give a meaningful demonstration of the use of the facility.

The use of the facility can also be used to demonstrate the diversion of green waste from landfill.

6.5 Cost effective compost production

A secondary aspect of the BVPI that Derbyshire and the Markham Willows facility must consider is the cost effectiveness of the route as a means of treating the waste arisings in Derbyshire. The districts must achieve best value for the treatment of their waste arisings in terms of cost and environmental performance.

Daily records and standard business accounting practices can be monitored to provide indications of the effective processing of the compost at costs which are no more than or less than that achieved at commercial composting facilities. This would essentially be reflected in the gate fee paid by the district authorities and other users and in the level of margin that the gate fee would provide to the facility.

7. Discussion

Government waste strategy and the European Landfill Directive will have a major impact on waste management in the county of Derbyshire. Significant and sustainable treatment facilities will need to be developed to deal with the diversion of waste from landfill and to process collected recyclable for further second phase treatment. With the county's current waste contracts due for renegotiation in 2005, one of the options that will be available to Derbyshire will be the establishment of a composting facility on the Markham Willows site. Composting at Markham Willows could help to meet one of the strategic aims of the waste strategy and would assist the county in diverting biodegradable waste from landfill. Given the political will, Markham Willows has the potential to expand to become an exemplar project involving many sustainable and integrated technologies all beneficial to the overall ethos of the project, sustainability, regeneration and employment.

The report considers the local realities for the project and the involvement of the district authorities; both from the aspect of procuring waste and also from the environmental regulation and governmental requirements that constrain the districts. It is essential that the districts that consider Markham Willows as a partner for the treatment of their waste can do so in complete confidence that they will meet best value guidelines criteria and that the use of Markham Willows stands up to auditable scrutiny. It will therefore be essential that the Markham Willows project identifies correctly the most effective technologies and cost effective procurement of services to provide a composting service, that is at a minimum competitive with commercial waste disposal operations and ideally offers a better solution. The Markham Willows project can do this by the use and integration of its equipment and services with other functions such as the maintenance and harvesting of the SRC plantations and the provision of quality composts for uses on the MEGZ development and other county and district grounds maintenance and parks departments. The nature of the composting operation means that there is a great deal of compatibility in terms of equipment use and labour skills that can be utilised elsewhere. This includes the use of equipment and labour to maintain and support the SRC willow plantations providing long-term all year round sustainable employment.

In September 2003, Derbyshire County Council gave planning permission for a composting facility on the Markham Willows site and indicated that the three district authorities of Bolsover, Chesterfield and North East Derbyshire who border the Markham Willows site could initially deliver in the region of 6,000 tonnes of green waste. This premise enabled the project team to carry out detailed and specific planning to establish feasibility of the composting facility and to present a range of options to Derbyshire. It was agreed with Derbyshire that the team would plan for a facility of 10,000 tpa capacity and the facility would handle green waste only, thus avoiding the more rigid regulatory requirements which would be required if catering waste was accepted.

An essential factor, which would allow the districts to contract with Markham Willows, was that the facility should provide best value, especially in terms of costs and environmental performance. The project team envisioned that this could be achieved by providing a discounted gate fee below current commercial rates.

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Modelling by AEA suggested that this may be possible if the facility were to process at least 10,000tpa. There would appear to be the potential to collect 10,000tpa of green waste given the size of the local population. There may also be the opportunity to increase throughput by receiving green waste from other sources such as commercial landscapers and private sector waste collection companies.

The short rotation coppice plantations would be the main user of the output of the composting facility. During the soil formation and willow planting over the period of establishment of the 60ha site, demand for compost would outstrip supply from the composted 6,00tpa at the Markham Willows facility. As a result, compost may need to be imported to the site during the period of plantation establishment if it is going to be used in the soil formation across the whole site.

After the establishment period, there would be a surplus of compost available, however the amount would depend on the rate of mulching used for the SRC in future years. It is envisioned that these materials would be available to the District Authorities and county council for use in ground keeping and estate maintenance activities. Alternative markets for compost have also been identified such as the APEX marketing project, which does purchase bulk quality compost for retail sale. Green waste composting should mean that the facility can produce compost to the British Standard PAS 100, which would enable the best prices to be paid for its output products, although these prices could still be fairly low in monetary terms.

The regulatory situation for green waste composting requires the facility to hold a waste management licence issued by the Environment Agency. This would require the site to be the responsibility of Derbyshire County Council and as such DCC would be required to provide suitable financial provision and suitable insurances. The waste management licence also requires that a person holding a current Certificate Of Technical Competency issued by WAMITAB be employed at the facility.

Based on collecting green waste only, the processing of the materials could be carried out in an open-air windrow system. Therefore the review has focused on establishing the costs of suitable infrastructure and the best options for the supply of mechanical equipment and services for the windrow composting. The design of the infrastructure was based on a hardwearing asphalt pad of 10,000m² with drainage to a leachate lagoon and circulation system. The buildings would be “Portacabin” type for mess rooms and office.

A number of options were identified for the procurement of equipment and contract services for the composting process. The range of options covers the outright purchase of various types of equipment through to the contracting in of services and equipment for use at the facility. The final choice of option will be critical to the profitability of the facility mainly due to the expected level of throughput. In simple terms, green waste inputs below 10,000tpa do not achieve high levels of equipment use and efficiency, which is consequently reflected in cost per tonne throughput.

The earliest possible start date for a full-scale composting facility at Markham Willows will be spring 2005 This is due to the need to apply for and obtain a Waste Management Licence and to tender and construct the facility, This will require a

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number of critical activities need to take place. DCC need to make their application for a Waste Management Licence while at the same time incorporating the requirements of the licence into a tender document for the civil construction works for the site infrastructure. These two activities will provide final base costs for the facility and allow the development of a gate fee structure, which can be incorporated into a formal contract between the county and the district authorities. Work on identifying alternative sources of feedstocks should also begin as do the requirement to reach a formal understanding on the pooling of labour and equipment across the project. Agreement between DCC and the district authorities will allow the placement of the infrastructure works contract with a civil engineering contractor, leading to completion of the composting facility at the end of 2004 with the first intake of green waste in late spring 2005.

8 Conclusions

The possible supply of approximately 6,000tpa of green waste has provided the composting phase of the Markham Willows project with a starting point from which it can develop. While 6,000tpa of green waste is unlikely to be commercially sustainable, it will provide the base-loading and justification to develop the necessary infrastructure and obtain the regulatory waste management licence necessary to operate a green waste composting operation. With a clear understanding of the facility in terms of capacity, capability and timing; meaningful discussion can take place with the private sector suppliers who are potential generators of biodegradable waste suitable for treatment in the facility.

Securing additional waste will be a key element in taking the facility into commercial sustainability within a reasonable timeframe. With infrastructure and operations in place, clear potential will exist for expansion and development of the composting facility, for example the provision of in-vessel systems to deal with a wider range of waste. Such a treatment facility will provide long-term employment and contribute to Derbyshire's recycling and composting efforts while playing a pivotal role in the Markham Willows project

9 Recommendations

There are number of priority tasks which must take place in order that the facility will be available to accept green waste by early 2005.

These are to:

- Begin the application for the waste management licence which requires immediate dialogue to begin with the Environment Agency
- Develop the tender for the civil engineering works for the composting pad, roads, drainage and leachate capture.
- Develop tenders for the supply of machines, equipment and services.
- Source and train suitable staff.
- Begin sourcing additional biodegradable waste.
- Develop contracts with the district authorities of the North East sub area.

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Appendix A: - Chart 1, Green waste input and compost production calculations

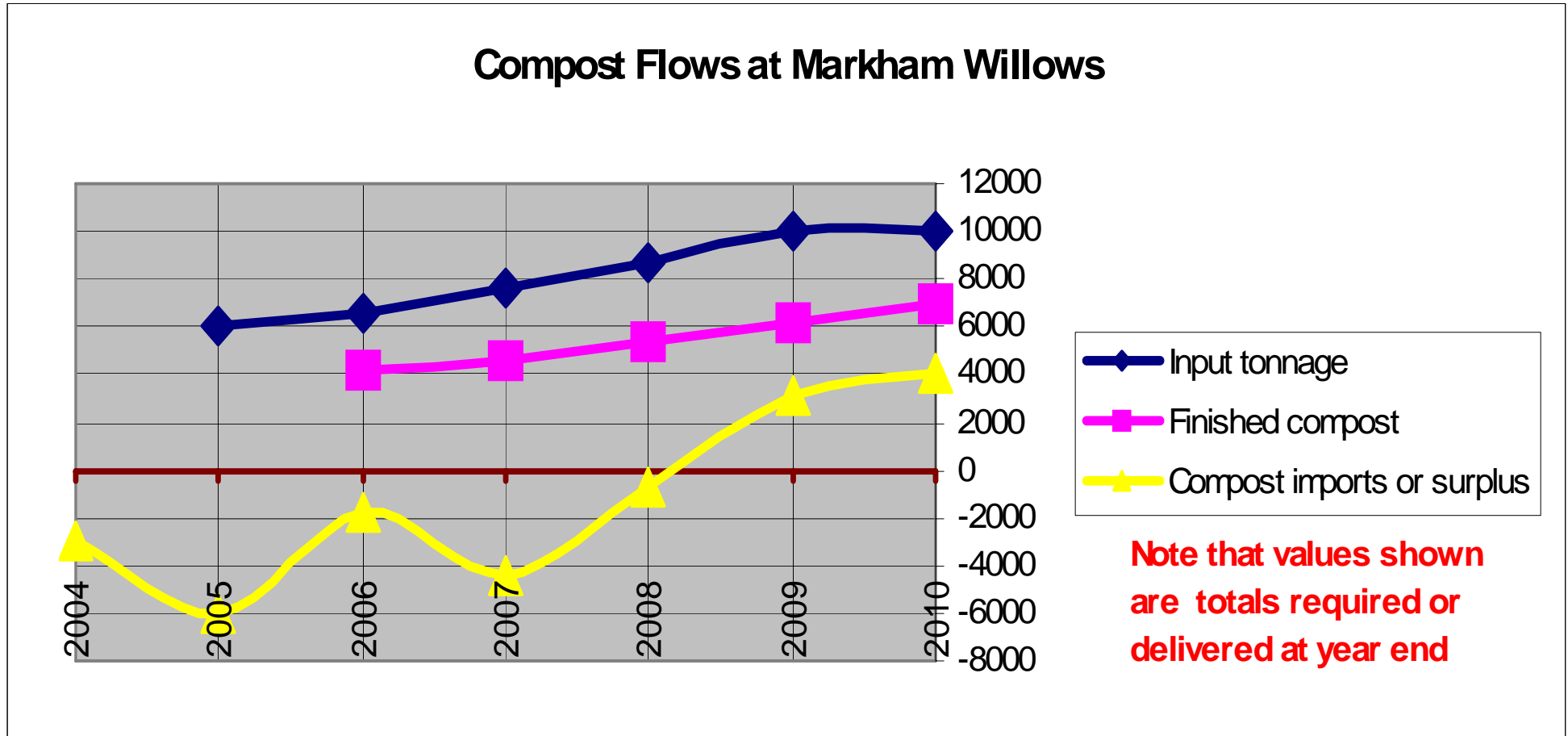
| Year | | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---------------|----------|--------------|--------------|--------------|---------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Project Year | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| | | TPA | TPA | TPA | TPA | TPA | TPA | TPA | TPA | TPA | TPA | TPA | TPA |
| Application rate required for compost t/y | | 0 | 3,000 | 6,000 | 6,000 | 9,000 | 6,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| Theoretical input tonnage required | | 0 | 4,286 | 8,571 | 8,571 | 12,857 | 8,571 | 4,286 | 4,286 | 4,286 | 4,286 | 4,286 | 4,286 |
| Compost reduction factor | 30.00% | | | | | | | | | | | | |
| Theoretical finished compost all size fractions | | 0 | 3,000 | 6,000 | 6,000 | 9,000 | 6,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| Finished Compost size fractions required | | | | | | | | | | | | | |
| <25mm | 0.00% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| SRC size fraction >25mm <75mm | 98.00% | 0 | 2940 | 5880 | 5880 | 8820 | 5880 | 2940 | 2940 | 2940 | 2940 | 2940 | 2940 |
| >75mm | 2.00% | 0 | 60 | 120 | 120 | 180 | 120 | 60 | 60 | 60 | 60 | 60 | 60 |
| | 100.00% | | | | | | | | | | | | |
| Finished compost required before screening | | 0 | 4,373 | 8,746 | 8,746 | 13,120 | 8,746 | 4,373 | 4,373 | 4,373 | 4,373 | 4,373 | 4,373 |
| Total application ton's required | | 0 | 3,000 | 6,000 | 6,000 | 9,000 | 6,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| Final input tonnage required | | 0 | 4,373 | 8,746 | 8,746 | 13,120 | 8,746 | 4,373 | 4,373 | 4,373 | 4,373 | 4,373 | 4,373 |

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Appendix A: - Chart 2, Application rates and sequence.

| Year | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|--|------|------|------|------|------|------|------|------|------|------|------|------|
| Soil formation Plot 1, Autumn 2003 | | 200 | | | | | | | | | | |
| Post cutback application Plot 1 | | | 200 | | | | | | | | | |
| Post harvesting application Plot 1 | | | | | 200 | | | | | | | |
| Post 2nd harvesting application Plot 1 | | | | | | | | | 200 | | | |
| Post 3rd harvesting application Plot 1 | | | | | | | | | | | | |
| Post 4th harvesting application Plot 1 | | | | | | | | | | | | |
| Soil formation Plot 2, Autumn 2004 | | | 200 | | | | | | | | | |
| Post cutback application Plot 2 | | | | 200 | | | | | | | | |
| Post harvesting application Plot 2 | | | | | | 200 | | | | | | |
| Post 2nd harvesting application Plot 2 | | | | | | | | | | 200 | | |
| Post 3rd harvesting application Plot 2 | | | | | | | | | | | | |
| Soil formation Plot 3, Autumn 2005 | | | | 200 | | | | | | | | |
| Post cutback application Plot 3 | | | | | 200 | | | | | | | |
| Post harvesting application Plot 3 | | | | | | | 200 | | | | | |
| Post 2nd harvesting application Plot 3 | | | | | | | | | | | 200 | |
| Post 3rd harvesting application Plot 3 | | | | | | | | | | | | |
| Soil formation Plot 4 Autumn 2006 | | | | | 200 | | | | | | | |
| Post cutback application Plot 4 | | | | | | 200 | | | | | | |
| Post harvesting application Plot 4 | | | | | | | | 200 | | | | |
| Post 2nd harvesting application Plot 4 | | | | | | | | | | | | 200 |
| Post 3rd harvesting application Plot 4 | | | | | | | | | | | | |
| Total for year compost | 0 | 200 | 400 | 400 | 600 | 400 | 200 | 200 | 200 | 200 | 200 | 200 |
| Total compost for year tons for 15Ha | 0 | 3000 | 6000 | 6000 | 9000 | 6000 | 3000 | 3000 | 3000 | 3000 | 3000 | 3000 |
| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |

Appendix A: - Chart 3, Compost flows during soil forming stage and SRC establishment.



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Appendix B: - Chart 1, Calculations for hire of machinery and use across full year.

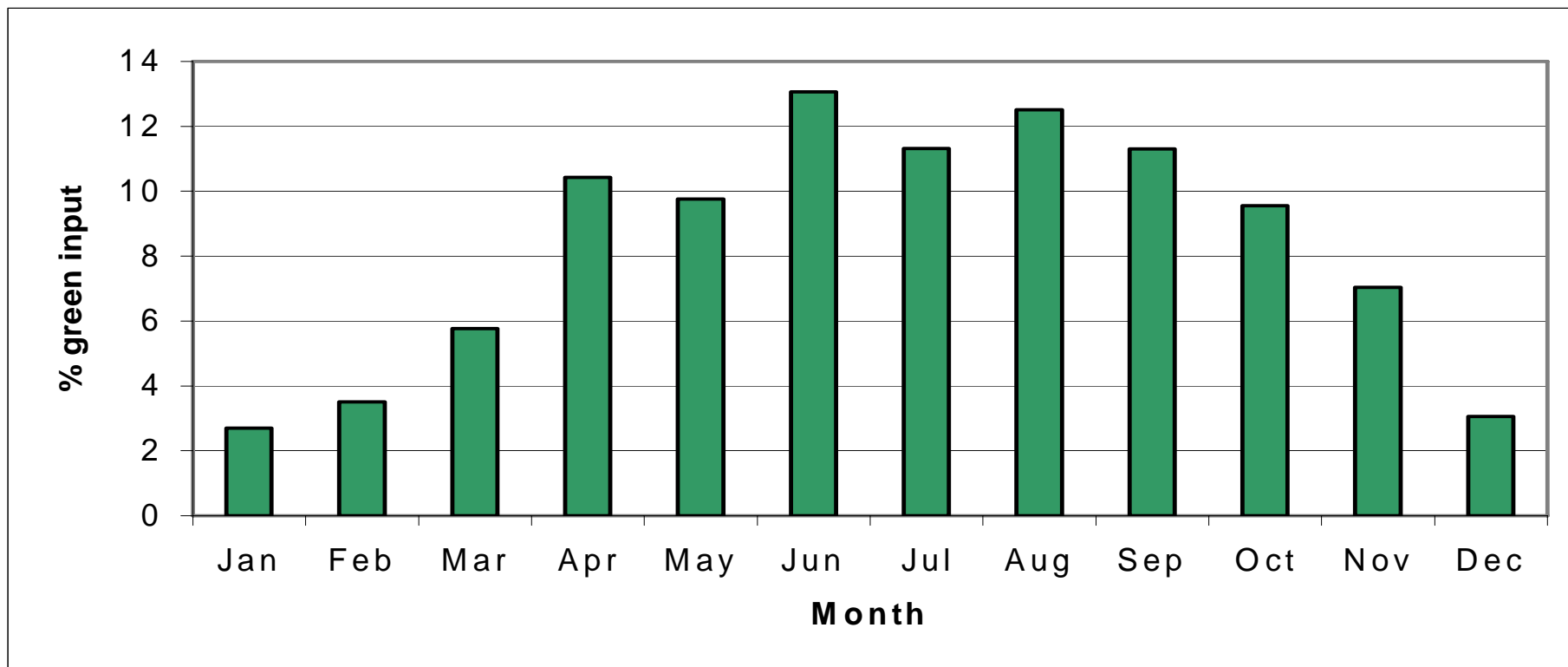
| Input Conditions | | January | February | March | April | May | June | July | August | September | October | November | December |
|--|-------------|---------|----------|--------|--------|--------|--------|--------|--------|-----------|---------|----------|----------|
| % waste input | | 2.75% | 3.50% | 5.75% | 10.50% | 9.75% | 13.25% | 11.00% | 12.25% | 11.00% | 9.50% | 7.00% | 3.75% |
| Waste input | 6000 | 165 | 210 | 345 | 630 | 585 | 795 | 660 | 735 | 660 | 570 | 420 | 225 |
| Amount of green waste stored before shredding (tons) | 100 | | | | | | | | | | | | |
| Number of batches a month | | 1.65 | 2.1 | 3.45 | 6.3 | 5.85 | 7.95 | 6.6 | 7.35 | 6.6 | 5.7 | 4.2 | 2.25 |
| Throughput of shredder t/h | 15 | | | | | | | | | | | | |
| length of time spent shredding in days/month (based on the hours per day value set in cell B7) | 8 | 1.4 | 1.8 | 2.9 | 5.3 | 4.9 | 6.6 | 5.5 | 6.1 | 5.5 | 4.8 | 3.5 | 1.9 |
| Hours Required to shred greenwaste | | 11 | 14 | 23 | 42 | 39 | 53 | 44 | 49 | 44 | 38 | 28 | 15 |
| Number of actual days required(rounded up or down) by the hire contractor to allow for extended working etc | | 1.38 | 1.75 | 2.88 | 5.25 | 4.88 | 6.63 | 5.50 | 6.13 | 5.50 | 4.75 | 3.50 | 1.88 |
| Number of working days available in month (5*4.3) | | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 |
| Average use of shredding equipment if permanently on site | 18.85% | 6.40% | 8.14% | 13.37% | 24.42% | 22.67% | 30.81% | 25.58% | 28.49% | 25.58% | 22.09% | 16.28% | 8.72% |

Appendix B: - Chart 2, Calculations for hire of machinery and use across full year.

| | | | | | | | | | | | | | |
|--|-------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|
| Shredder Hire | Rate | | | | | | | | | | | | |
| Days required/month | | 2.00 | 2.00 | 3.00 | 6.00 | 5.00 | 7.00 | 6.00 | 7.00 | 6.00 | 5.00 | 4.00 | 2.00 |
| Green waste shredder hire £/d | 400 | | | | | | | | | | | | |
| Green waste shredder cost per month | | 800 | 800 | 1,200 | 2,400 | 2,000 | 2,800 | 2,400 | 2,800 | 2,400 | 2,000 | 1,600 | 800 |
| Green waste shredder cost per year | 22,000 | | | | | | | | | | | | |
| Accumulated compost production | | | | | | | | | | | | | |
| Compost mass degrade rate | 30% | | | | | | | | | | | | |
| Compost Input | | 165 | 210 | 345 | 630 | 585 | 795 | 660 | 735 | 660 | 570 | 420 | 225 |
| Compost output | | 115.5 | 147 | 241.5 | 441 | 409.5 | 556.5 | 462 | 514.5 | 462 | 399 | 294 | 157.5 |
| Accumulated compost (3 monthly screening) | | 115.5 | 262.5 | 504 | 441 | 850.5 | 1407 | 462 | 976.5 | 1438.5 | 399 | 693 | 850.5 |
| Compost screening rate t/h | 15 | | | | | | | | | | | | |
| Number of hours required | | | | 33.6 | | | 93.8 | | | 95.9 | | | 56.7 |
| Length of working day in hours/number of days required | 10 | | | 3.36 | | | 9.38 | | | 9.59 | | | 5.67 |
| Actual days on site for hire charge | | | | 4 | | | 10 | | | 10 | | | 6 |
| Hire rate £/d | 300 | | | 1200 | | | 3000 | | | 3000 | | | 1800 |
| Total screening hire costs | 9000 | | | | | | | | | | | | |

This chart is used to assess the use of hire machinery to determine the costs for inclusion in cost options and uses data from Chart 1

Appendix B:- Chart 3, Typical variations in green waste procurement.³⁷



³⁷ Waste arising data provided by SITA. Typical delivery variations for green wastes delivered to SITA composting sites.

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Appendix B:-Chart 4, Typical machine costs

| Shredders, second hand | Type | year | Hours | throughput | Price | Source | Comments |
|---------------------------------|---------------|-------------|--------------|-------------------|--------------|------------------|--|
| Jenz | Hammer mill | 1993 | 5800 | 20t/h | 40-50k | Kendel Machinery | web site price |
| Willibald | Hammer mill | 1998 | 2900 | 25t/h | 90-100k | Kendel Machinery | web site price |
| Runick & Enners | Hammer mill | 1992 | 3600 | 15t/h | 30-40k | Kendel Machinery | web site price |
| Doppstadt | Hammer mill | 1990 | | | 40-50k | Kendel Machinery | web site price |
| Screens, Second Hand | | | | | | | |
| Farwick | Tromel | 1995 | 3220 | 15th | 30-40k | Kendel Machinery | web site price |
| Chippers, second hand | | | | | | | |
| Pezzolato | Rotor & blade | 1996 | 1500 | | 7.5-10k | Kendel Machinery | web site price Hand feed machine |
| Tele hoists, second hand | | | | | | | |
| JCB 550_70 | 550-70 | 2001 | 2059 | | 20-25k | Kendel Machinery | 7 meter lift, no bucket, web site price |
| Shredders New | | | | | | | |
| Green Mech | 1400-110 | | | 5-7t/h | 50,000 | Green mech | Verbal price from Managing director. Will produce fairy fine chip.27/10/03 |
| Doppstadt | 18-130 | | | 30t/h | 130,000 | Doppstadt UK | Verbal pricing George Kehoe 27/10/03 |
| Jenz | AZ-35-120-D | | | 15-20t/h | 100,000 | Westconuk | Verbal price from Director Neil Bond, advised with screen chnages, possible to shred green waste and willow 28/10/03 |
| Loading Equipment | | | | | | | |
| Front End Loaders | 436 | New | | | 80,000 | JCB | Verbal pricing, Holt JCB Graham Buckle, 03/11/03 |
| Front End Loaders Contract hire | 436 | New | | | 30,000 | JCB | Verbal pricing, Holt JCB Graham Buckle, 03/11/03 £2,500 per month with maint on 2500hrs |
| Tele handlers, contract hire | | New | | | 10,400 | John Deere | Verbal pricing,ADM Jenkin, Lincoln (Donovan) 31/10/03 |
| Tele hoists | 530- 70 | New | | | 30,000 | JCB | Verbal pricing. Ian Elston, Watling JCB 27/10/03 |
| 360 Excavators | JS 130W | New | | | 75,000 | JCB | Verbal pricing. Ian Elston, Watling JCB 27/10/03 |
| Windrow Turners | | | | | | | |
| Doppstadt | DU 265 Panda | New | | 500m/3/h | 175,000 | Doppstadt UK | Verbal pricing George Kehoe 27/10/03 Minimum size 500m/3 hr |
| SEKO | RIV 300 | New | | | 90,100 | Harry West | Web site pricing 29th Oct 2003 |
| Tromel screen | | | | | | | |
| Doppstadt | 1210 | New | | | 75,000 | Doppstadt UK | Verbal pricing George Kehoe 27/10/03 |

**Appendix B:- Chart 5, Machine Procurement Options.
(6,000tpa input)**

| Option 1 Lowest cost purchase using new and second hand | cost | Recovery cost per ton input year 1 | Recovery cost per ton input over 3 years |
|--|------------------|---|---|
| Loading and windrow building by JCB 535-70 tele hoist (New) | 30,000.00 | 5.00 | 1.67 |
| Jennz shredder for green waste shredding (S/hand) | 40,000.00 | 6.67 | 2.22 |
| Windrow turning using the same JCB 535-70 tele hoist | 0.00 | 0.00 | 0.00 |
| Screening using second hand screen (s/hand) | 20,000.00 | 3.33 | 1.11 |
| Bulk outloading using same JCB 535-70 tele hoist | 0.00 | 0.00 | 0.00 |
| | 90,000.00 | 15.00 | 5.00 |

| Option 2 Purchase using all new equipment. (Marginal Equipment Solution) | cost | Recovery cost per ton input year 1 | Recovery cost per ton input over 3 years |
|---|----------------|---|---|
| Loading and windrow building by JCB 535-70 tele hoist (New) | 30,000 | 5.00 | 1.67 |
| Jennz shredder for green waste shredding (New) | 100,000 | 16.67 | 5.56 |
| Windrow turning using the same JCB 535-70 tele hoist | 0 | 0.00 | 0.00 |
| Screening using Doppstadt screen (New) | 75,000 | 12.50 | 4.17 |
| Bulk outloading using same JCB 535-70 tele hoist | 0 | 0.00 | 0.00 |
| | 205,000 | 34.17 | 11.39 |

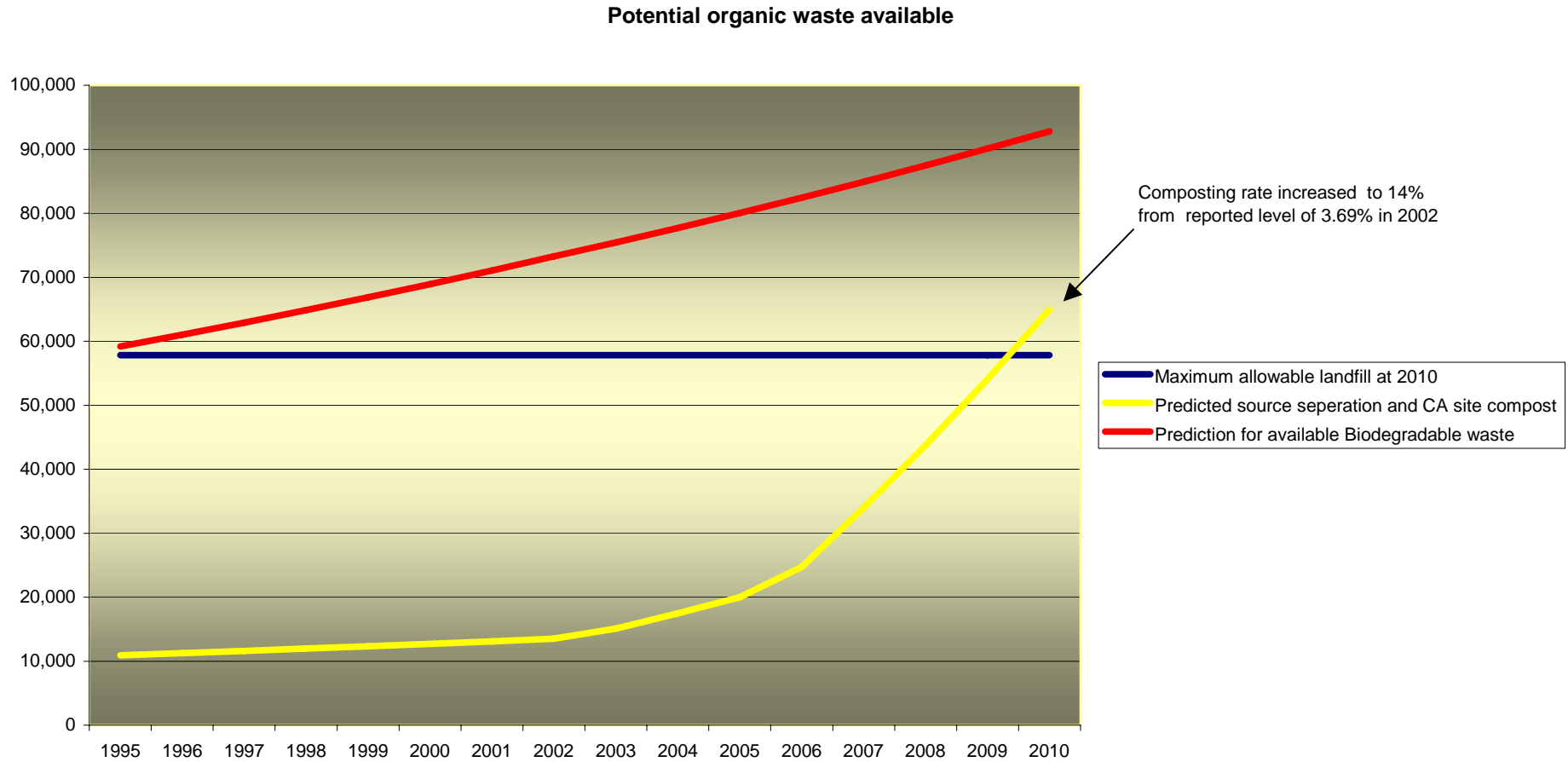
| Option 3 Purchase using all new equipment with JCB 436 front end loader instead of tele hoist (Robust equipment solution) | Purchase cost | Recovery cost per ton input year 1 | Recovery cost per ton input over 3 years |
|---|----------------------|---|---|
| Loading and windrow building by JCB 436 FEL (New) | 79,000 | 13.17 | 4.39 |
| Jennz shredder for green waste shredding (New) | 100,000 | 16.67 | 5.56 |
| Windrow turning using the same JCB 436 FEL | 0 | 0.00 | 0.00 |
| Screening using Doppstadt screen (New) | 75,000 | 12.50 | 4.17 |
| Bulk outloading using same JCB 436 FEL | 0 | 0.00 | 0.00 |
| | 254,000 | 42.33 | 14.11 |

| Option 4 Hire of shredder and screen, contract hire of JCB telehoist. | Purchase cost | Recovery cost per ton input year 1 | Recovery cost per ton input over 3 years |
|--|----------------------|---|---|
| Loading and windrow building by JCB 530-70 (Contract Hire) | 10,400 | 1.73 | 1.73 |
| Hire Shredder (costs per year for day hire) | 22,000 | 3.67 | 3.67 |
| Windrow turning using the same JCB 530 tele hoist | 0 | 0.00 | 0.00 |
| Hire Screen (costs per year) | 9,000 | 1.50 | 1.50 |
| Bulk outloading using same JCB 530 tele hoist | 0 | 0.00 | 0.00 |
| | 41,400 | 6.90 | 6.90 |

| Option 5 Hire of shredder and screen, purchase of JCB 436 FEL | Purchase cost | Recovery cost per ton input year 1 | Recovery cost per ton input over 3 years |
|--|----------------------|---|---|
| Loading and windrow building by JCB 436 FEL (New) | 79,000 | 13.17 | 4.39 |
| Hire Shredder (costs per year) | 22,000 | 3.67 | 3.67 |
| Windrow turning using the same JCB 436 | 0 | 0.00 | 0.00 |
| Hire Screen (costs per year) | 9,000 | 1.50 | 1.50 |
| Bulk outloading using same JCB 436 | 0 | 0.00 | 0.00 |
| | 110,000 | 18.33 | 6.11 |

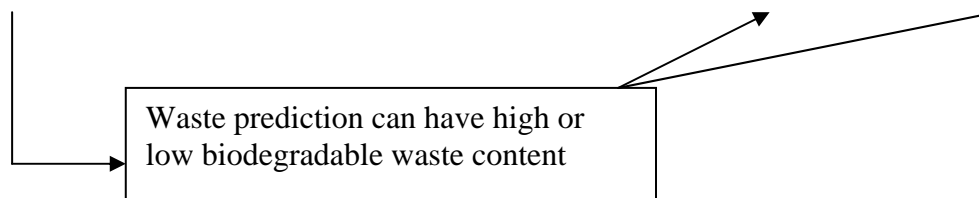
| Option 6 Hire of shredder and screen, Contract hire of JCB 436 FEL | Purchase cost | Recovery cost per ton input year 1 | Recovery cost per ton input over 3 years |
|---|----------------------|---|---|
| Loading and windrow building by JCB 436 FEL (New) | 30,000 | 5.00 | 5.00 |
| Hire Shredder (costs per year) | 22,000 | 3.67 | 3.67 |
| Windrow turning using the same JCB 436 | 0 | 0.00 | 0.00 |
| Hire Screen (costs per year) | 9,000 | 1.50 | 1.50 |
| Bulk outloading using same JCB 436 | 0 | 0.00 | 0.00 |
| | 61,000 | 10.17 | 10.17 |

Appendix C: -Chart 1, Prediction of Availability of Biodegradable Waste in Derbyshire

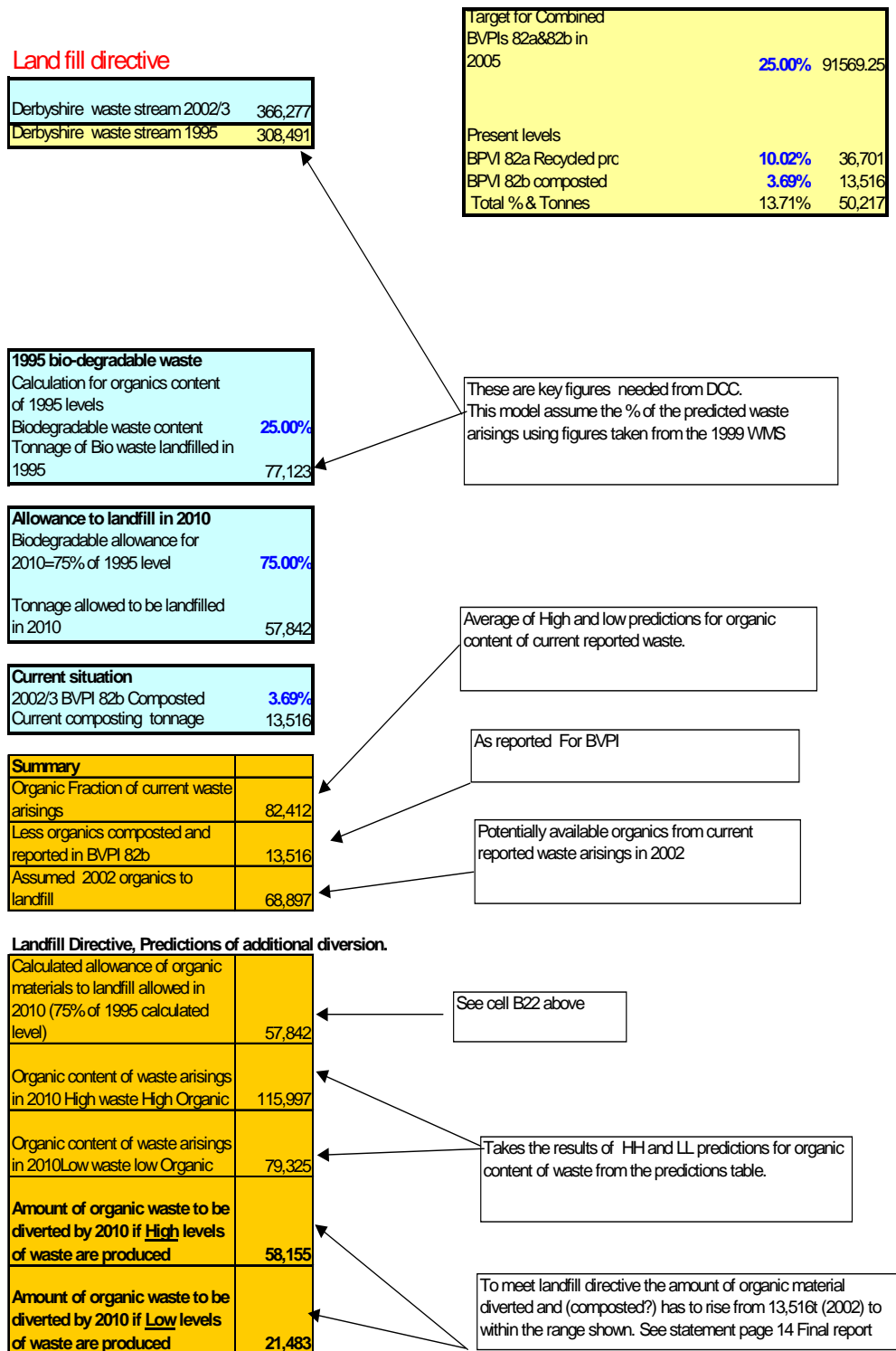


Appendix C:- Chart 2, Waste Model 2: Predictions of waste and biological content based on 2002 waste arisings

| Year | | High Waste escalator Waste increases at 3% | Low waste escalator Waste increases at 1% | High Organics 25% High waste | Low Organics 20% High waste | High Organics 25% Low waste | Low organics 20% Low waste |
|-------------|----------------|--|---|------------------------------|-----------------------------|-----------------------------|----------------------------|
| 1995 | | 295,946 | 341,394 | 73,986 | 59,189 | 85,349 | 68,279 |
| 1996 | | 305,098 | 344,843 | 76,275 | 61,020 | 86,211 | 68,969 |
| 1997 | | 314,535 | 348,326 | 78,634 | 62,907 | 87,081 | 69,665 |
| 1998 | | 324,262 | 351,844 | 81,066 | 64,852 | 87,961 | 70,369 |
| 1999 | | 334,291 | 355,398 | 83,573 | 66,858 | 88,850 | 71,080 |
| 2000 | | 344,630 | 358,988 | 86,158 | 68,926 | 89,747 | 71,798 |
| 2001 | | 355,289 | 362,614 | 88,822 | 71,058 | 90,654 | 72,523 |
| 2002 | 366,277 | 366,277 | 366,277 | 91,569 | 73,255 | 91,569 | 73,255 |
| 2003 | | 377,265 | 369,940 | 94,316 | 75,453 | 92,485 | 73,988 |
| 2004 | | 388,583 | 373,639 | 97,146 | 77,717 | 93,410 | 74,728 |
| 2005 | | 400,241 | 377,376 | 100,060 | 80,048 | 94,344 | 75,475 |
| 2006 | | 412,248 | 381,149 | 103,062 | 82,450 | 95,287 | 76,230 |
| 2007 | | 424,615 | 384,961 | 106,154 | 84,923 | 96,240 | 76,992 |
| 2008 | | 437,354 | 388,810 | 109,338 | 87,471 | 97,203 | 77,762 |
| 2009 | | 450,475 | 392,699 | 112,619 | 90,095 | 98,175 | 78,540 |
| 2010 | | 463,989 | 396,626 | 115,997 | 92,798 | 99,156 | 79,325 |



Appendix C:- Chart 3, Calculations and model data for 1995 landfill allowance.



Appendix D:- The Composting Association Certification Scheme

Composting Association Certification Scheme trebles its numbers - 28 August 2003

[n](#)

Over 50% of the UK's high quality compost is now being assessed for certification from the Composting Association, with the number of compost producers joining the scheme more than trebling since April 2002.

Together, the 21 compost producers currently on the scheme have applied for certification of 27 composting processes and 40 composts. This represents nearly 430,000 tonnes of processing capacity per annum – about 51% of the estimated UK total for high value applications in markets such as amateur and professional horticulture, soft landscaping and grounds maintenance.

WRAP has been working closely with the Composting Association to develop the Certification Scheme. It provides 3rd party certification of conformity with the British Standards Institution's Publicly Available Specification for Composted Materials (BSI PAS 100), which was launched in November 2002. Anne O'Brien, Head of Organics at WRAP, says: "We are absolutely delighted with the response we have received from the composting industry. Producers have shown that they are ready to step up to the challenge of manufacturing a better quality product. This is welcomed, not just by buyers in landscaping and horticulture, but also by local authorities commissioning new composting services."

Dr Jane Gilbert, Chief Executive of the Composting Association, adds: "In a little over a year we have increased the amount of high quality compost on the certification scheme from 17% of the UK manufacturing capacity to over 50%, which is a fantastic accomplishment."

The Composting Association's Certification Scheme provides independent, thorough and regular checks on compost production, quality and labelling. Participating companies are required to:

- regularly monitor compost quality and ensure it meets, at least, the minimum specification in PAS 100;
- establish a quality policy and document production procedures; and
- provide accurate, up-to-date information about their products.

John Wakefield, Technical Director at Vital Earth Group, one of the latest compost producers to join the Certification Scheme, says: "Applying for certification has helped us put systems in place for manufacturing a consistently high quality product, which we believe is key to maintaining our reputation, and our clients. Achieving certification from the Composting Association is a key element of our expansion plan, which will see our processing capacity increase from 11,000 tonnes to 100,000 tonnes per annum by the end of 2004."

BSI PAS 100 for Composted Materials has been adopted by the Composting Association as the minimum specification that composted materials must meet in order to carry their certification mark. Building on PAS 100, WRAP is currently developing a series of guidelines and specifications for the use of compost for a variety of end uses including landscaping and horticulture.