



Chapter 4

PROMISING TECHNOLOGIES SHORT TERM



4.1 Overview

The technologies most appropriate for diverting waste from landfill in South Africa in the first instance are described in this section. They are as follows, and discussed in this chapter:

- Open windrow composting
- Clean materials recycling facility
- Dirty materials recycling facility

4.2 Open window composting

Composting is the simplest form of biological treatment and is suitable for the treatment of some source-segregated biological or organic / putrescible waste streams.

Biological treatment uses technologies to treat biodegradable wastes under tightly controlled or managed conditions. All biological waste treatment processes involve the decomposition of biodegradable wastes by living micro-organisms, or microbes, such as bacteria and fungi. These microbes use the waste as a food source for growth and multiplication.

The microbes excrete specialised chemicals (enzymes) which digest organic substances from the waste (e.g. complex carbohydrates, proteins, fats) into simple nutrients (e.g. sugars, amino acids, fatty acids) that are absorbed for microbial nutrition. As the microbes grow, they convert a significant proportion of the organic matter into heat, gases and water – leading to large mass losses which can occur during biological waste treatment.¹

There are two main conditions under which such microbes thrive; therefore there are two main categories of biological processes used to treat biodegradable waste:

- Aerobic – decomposition of the waste in the presence of free oxygen; and
- Anaerobic – decomposition of the waste in the absence of free oxygen

Organic waste treatment facilities must hold the relevant Waste Management Licence for operation, as required under the Waste Act. Open windrow composting is an aerobic decomposition technique, and is discussed in the following sections, anaerobic digestion methods are discussed in further detail in Chapter 5.3.



¹In some biological treatment processes such as certain 'wet AD' technologies, water may be added or liquor recirculated and in these instances the mass reduction will be smaller, unless there is subsequent dewatering.

4.2.1 An explanation of composting

Composting of organic waste material is a well-established process, both commercially and domestically. It is a **technique proven for the treatment of green garden waste** and may be used for some food waste.² Green garden waste may be composted either in open windrows (elongated piles), as described here, or in enclosed facilities (in-vessel composting) as described in Chapter 5.4).

4.2.2 Composting process

Aerobic composting is the **decomposition (in the presence of oxygen) of organic material through microbial action** to residual solids (a stabilised³ dried material, or compost), heat, carbon dioxide and water. Aerobic composting is a relatively dry process for materials with high solids content of around 40-60%. When managing the process it is **important to ensure that the carbon to nitrogen balance of materials is kept in equilibrium**.

Composting produces a large amount of heat through the respiration of microbes; typically (thermophilic) temperatures of around 55-70°C are obtained, which if maintained and controlled, can have the advantage of sanitising the waste and drying the material. Provided that a steady feedstock is available and oxygen, moisture, acidity and temperature levels are maintained, then the process will occur continuously and be self-maintaining. This is the reason for turning compost to allow full aeration and to continue the decomposition process. In some systems, air is blown or drawn through material, to speed up the drying and/or decomposition of the material.

As the decomposition process progresses, heat, carbon dioxide and moisture are lost to the atmosphere, leaving a stable mixture of woody fragments, micro-organisms and humus. If any contamination (for example non-biodegradable components) are in the feedstock material then these will also be present in the material output, unless screened or removed prior to or post the composting operation itself. When produced from source-segregated organic waste, the resulting product is known as 'compost'; when produced from non-source segregated waste, it may be known as 'stabilised bio-waste' or 'compost like output' (CLO). **A simplified mass balance of the Composting process** is shown in Figure 4.

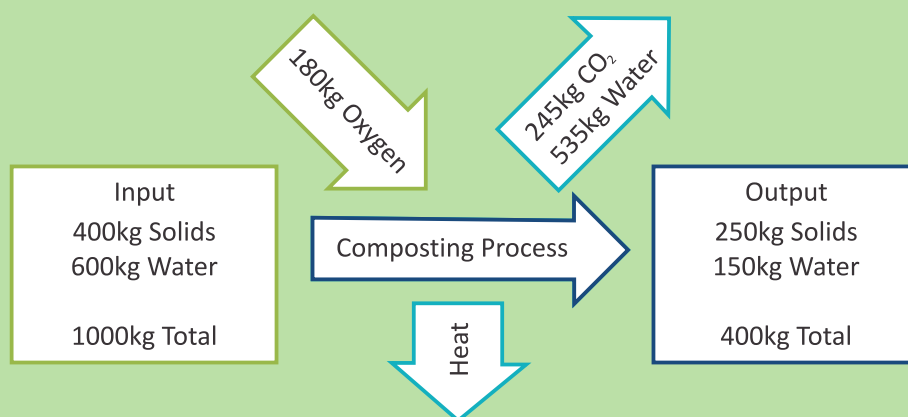


Figure 4: Example composting mass balance

²There can be health issues with processing animal by-products wastes (e.g. waste meat) as the lack of full sterilisation of the waste and exposure to the environment (e.g. birds, vermin etc.) may provide a pathway for disease transfer. Food wastes in the EU are composted under controlled conditions and in-vessels to avoid this issue.

³Stabilised is the degree of processing and biodegradation at which:

- The rate of biological activity under favourable aerobic biodegradation has slowed;
- The microbial respiration will not revive significantly until environmental conditions are altered.

There are a range of designs for aerobic composting technologies. All systems supply air/oxygen, control temperature and moisture levels to optimise the process.

At the time of writing, the Department of Environmental Affairs was consulting⁴ on its proposals for setting national standards for composting facilities with capacity of 10-100 tonnes per day. Issues such as site location, construction considerations, emissions and operation are included. Once enacted, these standards will apply to all facilities within the threshold.

In its simplest form, **composting takes place in the open air in large elongated uniform prism shaped 'piles' of waste known as windrows**. Historically, this has been the standard form for commercial green garden waste and on-farm composting operations, and is suitable for grass cuttings, prunings and leaves. It is not suitable for composting food or catering waste, as the process is open to the air and cannot be controlled to demonstrate the achievement of the sustained high temperatures required for sanitisation.⁵

The **waste feedstock is mechanically shredded and placed into long windrows on a solid, non-permeable surface**. Water may be added, depending on the moisture content of the waste. The windrows are turned regularly, either with a wheeled loader for small-scale operations or by a specialist windrow turner machine (pulled along by a tractor / a dedicated vehicle) for larger sites. **Turning the windrows assists with oxygen distribution in the mass, spreads the heat and water and helps to regulate the temperature**. The windrows are turned several times during the composting process, which takes in the region of **twelve to sixteen weeks**, depending on the product quality and maturity requirements.

The composting process consists of three main stages, as shown in the diagram below (Figure 5).

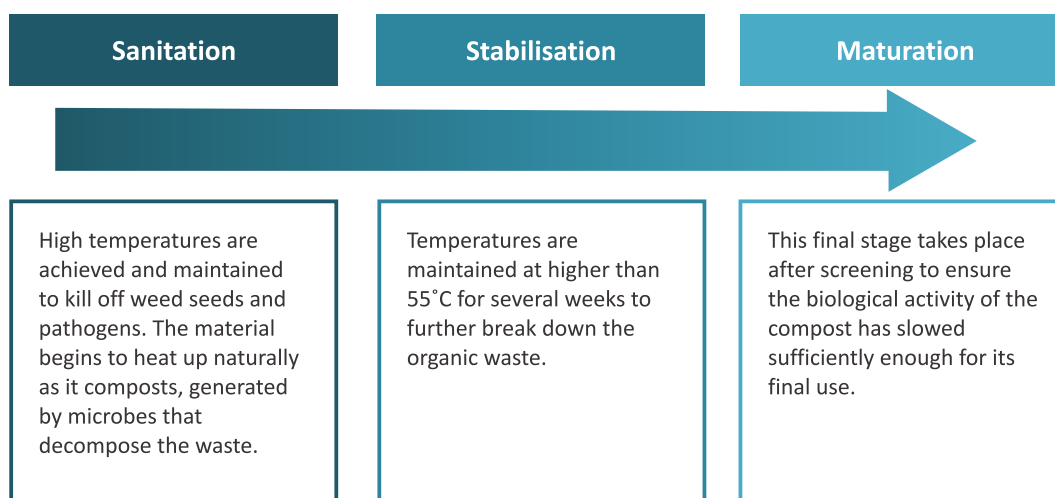


Figure 5: Composting process steps

During screening of the compost, contaminants such as plastics and metals are mechanically removed. **Screening also allows the material to be graded on size** for different end uses, typically 0-40mm grades. Oversized organic materials removed in the screening can be put back through the whole process until they are sufficiently composted.

⁴National Environmental Management: Waste Act 2008, Draft National Norms and Standards for Organic Waste Composting (Notice 68 of 2014).

⁵Within the EU, legislation exists for the control of catering waste treatment under the Animal By-Products Regulations.

4.2.3 Windrow composting configurations

Here, the windrow composting process is summarised by way of example configurations of the various technology components.

| | |
|--------------------------------|---|
| Waste streams accepted | Putrescible / organic waste, garden / food waste collections |
| Input capacity ranges | 5k ⁶ – 500k tonnes per annum |
| Typical outputs | Compost |
| Purpose | To recycle biodegradable waste into compost for land application / soil improvement |
| Indicative capital cost | Upwards of R 7.75m ⁷ for small scale simple windrow systems |

Table 4: Key characteristics of windrow composting

A **typical windrow composting process flow diagram** is presented in Figure 6. Each of the process stages is summarised below.

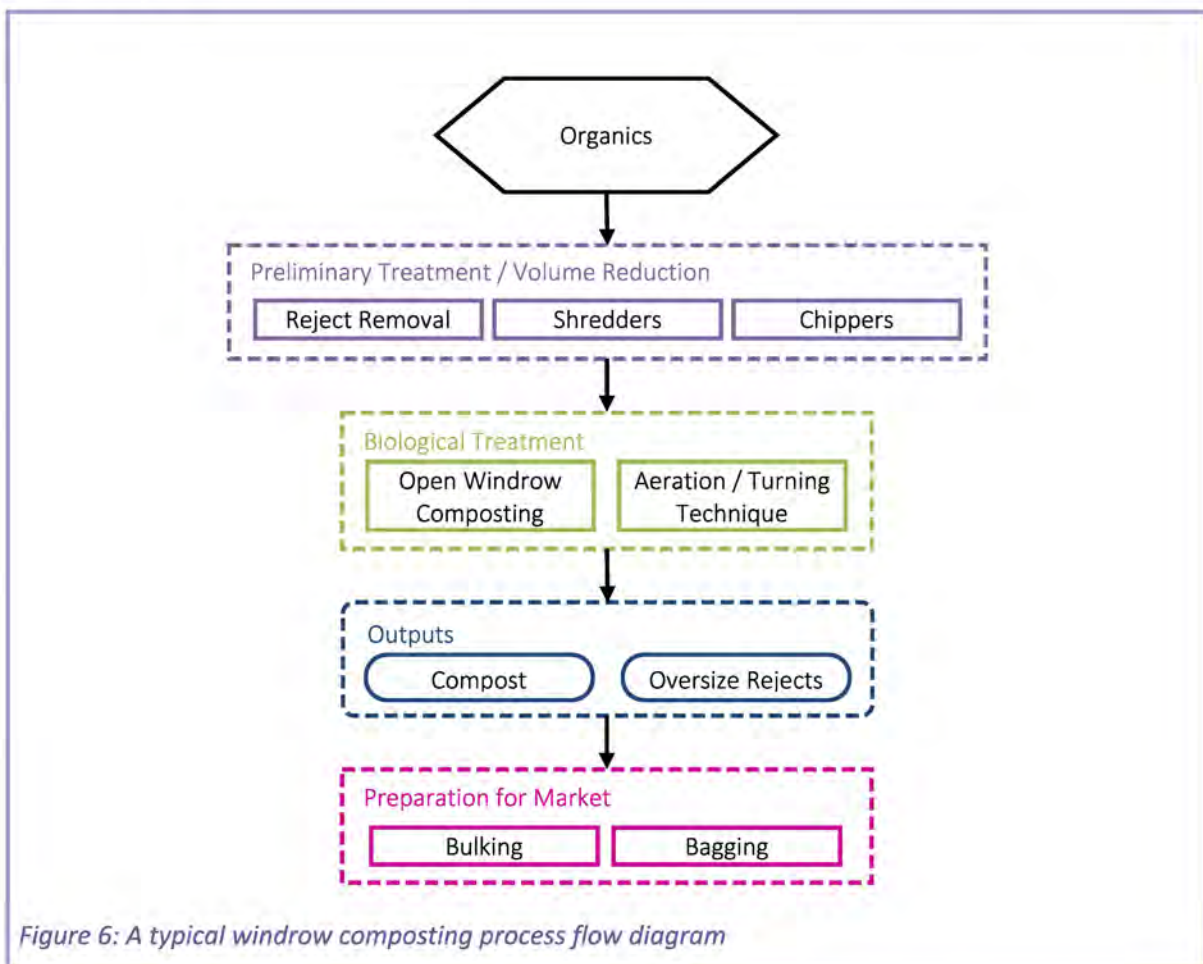


Figure 6: A typical windrow composting process flow diagram

⁶ All capacities in this document are provided in thousands (k) of tonnes, i.e. 1ktpa is 1,000 tonnes per annum.

⁷ Prices have been converted from experience of costs in a European context and are only used as an indicative cost. Quotes should be sourced directly from the market for accurate capital cost requirements.

4.2.4 Preliminary treatment / volume reduction stage

Source segregated organic wastes will often require a limited amount of treatment prior to composting. Firstly waste will be screened and **any oversize items or obvious contaminants removed**, for example tree branches or large inert materials. Following this the waste will be either **shredded or chipped** to increase the surface area and reduce the average material size in order to speed up the biological composting process.

4.2.5 Biological treatment stage

The organic waste is composted in windrows, or less commonly in static piles, for 3-4 months until **the waste feedstock has been completely decomposed** and matured into a valuable soil conditioner. To aid the process, and for consistency amongst the output, the windrows will be aerated and turned mid process, often several times. It is usual that a tractor will be used to agitate/turn the windrows; although more advanced mechanical systems (e.g. dedicated windrow turning machines) do exist at a premium.

4.2.6 Process outputs

The majority of material that is accepted for composting will be composted, with a small amount of rejects removed and sent for disposal. The composting process will reduce the moisture content of feedstock and therefore **the quantity of compost produced will be lower than the quantity of feedstock provided**. The compost may be suitable for use as a soil improver for horticultural and agricultural purposes, or for large scale remediation / landscaping works.

Outputs to be used as fertilisers come under the control of the Department of Agriculture, Forestry and Fisheries, and must meet all the necessary requirements set out in the Regulations Regarding Fertilisers (GNR 732).

Terminology relating to these outputs is used to differentiate between product from the treatment of source separated organic material and mixed residual waste:

- Compost – generally refers to the product from the aerobic biological treatment of source separated organic material (i.e. garden waste and / or food waste).
- Stabilised biowaste – generally refers to the compost-like output from mechanical biological treatment of mixed residual waste (see Chapter 5.5).

4.2.7 Preparation for market stage

The compost can either be bulked for mass onward transit or bagged for collection by / sale to local small scale users depending upon the desired end use.



Figure 7: Compost piles (Kyalami); composting windrows (image courtesy of Blue Group)

Within the context of South Africa, the development of the National Waste Management Strategy (2011) was an important milestone in the implementation of the National Environmental Management: Waste Act (Act No. 59 of 2008). The National Waste Management Strategy **promotes composting as one of the approaches towards achieving the objectives of the waste management hierarchy**, amongst other measures. During 2013, the Department of Environmental Affairs (DEA) developed a National Organic Waste Composting Strategy (NOWCS) to promote the diversion of organic waste from landfill sites for composting.



The National Waste Information Baseline Report (2012) (NWIBR) estimates the total general organic waste generated in South Africa to be in the region of 3 million tonnes for the year 2011, of which approximately 35% is currently recycled and the remainder (about 2 million tonnes) is landfilled. Almost 45% of all organic waste produced in South Africa is generated by only two Provinces; Gauteng (24%) and KwaZulu-Natal (20%). The Draft National Waste Information Baseline Report (May, 2012) furthermore highlights the differences in the composition of domestic waste between the different municipalities and states that **the proportion of organic waste in the domestic waste stream ranged between 10% and 58%**.

Composting in South Africa is largely undertaken by the private sector. A number of municipalities also undertake composting, **but generally the quality of municipal compost is poor and the production costs high**. Various studies indicate that the most common practice of composting is by means of static windrows/piles and turned-windrows with certain facilities employing forced aeration. Other composting methods include home composting systems, vermicomposting, in-vessel composting and co-composting with sewage sludge, agricultural and certain industrial organic waste. Most composting facilities in South Africa are based on the use of minimal-technology. Several of the larger metro-municipalities undertake chipping of garden wastes (often out-sourced to private contractors) where, in most cases, the chipped organic wastes are composted.

It is generally considered that **the demand for good quality compost in South Africa exceeds the supply**, providing opportunity for a greater diversion of organic wastes from landfilling, especially with regards to garden wastes and other uncontaminated organic waste streams.



Case study: Belleville south composting plant, Kraaifontein, Western Cape

Background

The Radnor and Bellville South Compost plants were developed in the late 1960s by the City of Cape Town to **treat MSW** and convert the organic component into compost. However, both the quality and sales of compost have declined over the last decade, for various reasons. The municipality took a decision to close the Radnor facility. The Radnor facility incorporated a Buhler rotating vessel which received mixed municipal general waste and food wastes.



The existing facility at **Bellville South annually produces 8,350 tonnes of compost from 14,266 tonnes (approximately 90 tonnes per day) of incoming waste**. Incoming waste is received from the Durbanville and Bellville areas only, due to the amount of green waste in their general waste stream. Approximately 6,000 tonnes of the incoming waste is rejected and landfilled at the Bellville South Landfill site.

Facility parameters



Due to space constraints, the plant can accommodate a maximum of **6 windrows**, each consisting of 800-1000m³ of material. The plant has a total of **18 staff**. Mechanical equipment includes sorting conveyors, a ball mill, magnetic separator, a baler for recovered ferrous metal cans, sieves, bag-filler and a front-end loader for windrow turning. Compost is turned once the pile has had a month's exposure in the field, and is processed after 6 months' exposure time.

The pile is then sifted through 2 sets of sieves, a 20.5mm sieve and a 5mm sieve. Quality tests are performed on a regular basis (at least bi-monthly) by the City's Scientific Services Department.

The facility would ideally require a greater proportion of green waste to be mixed with the waste stream, but green waste is also recycled as part of a City chipping tender which is currently undertaken by private contractors who in turn produce compost at privately-owned and operated composting facilities.

Source

City of Cape Town: Municipal Systems Act: Section 78(3) Assessment: Solid Waste Management: Status Quo Report, June 2010.

4.2.8 Concluding comments

Open windrow composting is a **relatively low capital waste treatment process**. It requires a concrete pad and some turning equipment / mobile plant and some screening and shredding equipment, the nature of which will depend on the feedstock, any contamination present and the requirements of the market into which the compost is to be delivered.

Green waste, by its nature is a seasonal feedstock that will **vary widely in terms of arisings throughout the year** and to a lesser extent, from year to year dependent on the prevailing weather conditions. Some flexibility is required in operational practice to manage these issues.

The **collection infrastructure supplying into the composting process will have an impact on the types of wastes received**, for example waste from parks services may contain larger branches and more woody materials than those from household waste. These aspects should be considered in the planning of the compost facility.

There can be **respiratory / health issues associated with bioaerosols** from turning compost and some odour issues. It is recommended that sites are located at least 200m away from sensitive receptors (e.g. housing). Those working on the **sites should also follow good practice** in terms of minimising the potential impact of inhaling bioaerosols, example measures include:

- Wearing respiratory protection
- Ensuring cabs of tractors are air conditioned and properly closed during the turning operation (the point of highest exposure) and that filters in the cabs are properly maintained

Further information on occupational health is available from a UK report by the Health & Safety Executive, available at www.hse.gov.uk/research/rrhtm/rr786.htm.

4.3 *Clean materials recycling facility*

A clean materials recycling facility (MRF) utilises **mechanical separation techniques to further sort a partially segregated waste stream into fractions** suitable for sale onto reprocessors. Materials accepted at a clean MRF will consist in the majority of dry recyclable materials, with key prominent fractions including glass, metal, paper and plastic. Clean and dirty MRFs rely on the sale of end products to reprocessors as a major revenue stream. Therefore it is important to establish that long term markets are available for the products, and during planning to model revenue based on temporal fluctuations that the price materials can be sold at.

4.3.1 *Mechanical treatment*

Mechanical treatment systems are used in various stages of waste treatment. They can be used for sorting and separation processes as part of materials recycling facilities (MRFs) key function, shredding and screening as a pre- or post-treatment stage of biological and thermal treatment, or used in conjunction with biological or thermal treatment as part of mechanical biological treatment (MBT) and mechanical heat treatment (MHT) system for mixed waste streams.

The three main stages in which mechanical waste treatment is used are:

- Preparation – to prepare the waste for further treatment
- Separation – for sorting and separation of waste into its component materials
- Post-treatment – to 'refine' the waste / product as a final stage before market and after the main treatment stage



4.3.1.1 Mechanical preparation treatments

Various equipment and technologies are used to mechanically prepare waste for further treatment. The selection of the equipment will depend on the type of waste delivered and the downstream treatment processes. For example, if mixed recyclate is collected from households, source separated, in bags or sacks, a bag splitter would be required. The main function and operational considerations of key technology components for mechanical preparation of waste are summarised in the Technical Glossary, Table 16.

4.3.1.2 Mechanical separation treatments

Separation techniques are used to sort the waste into component parts. Techniques range from simple hand sorting to highly technical electronic equipment. Usually arranged as a combination of several separation technologies, the exact configuration will depend on the type of waste feedstock and the target materials sought for separation. The main separation function and operational considerations of the main technology components for mechanical preparation of waste are summarised in the Technical Glossary, Table 17.

4.3.1.3 Mechanical post-treatment

Mechanical post-treatment technologies may be used for final 'polishing' of the process outputs to increase quality, meet the required standards and to remove any remaining contaminants. In addition, mechanical techniques are also employed to facilitate transport and logistics (for example baling of recyclables or refuse derived fuels). Mechanical post-treatment technologies are often applied after mechanical separation, biological treatment or thermal treatment stages. The main functions and operational considerations of the various techniques are summarised in the Technical Glossary, Table 18.

4.3.2 Clean MRF configurations

Here, the clean MRF process is summarised by way of example configurations of the various technology components.

A clean materials recycling facility (MRF) is **suitable for the processing of dry mixed recyclables**, which are collected separately from other residual wastes at the collection point. The recyclables can be sourced from a number of suitable collections; namely, a domestic household recycling collection, a commercial dry recycling collection or recycling collected by authorities at bring sites / civic amenity sites / drop off points. A clean MRF will segregate a mixed recycling stream into its component constituents **dependent upon a number of waste stream properties, typically by materials and then by grade**.

| | |
|-------------------------|--|
| Waste streams accepted | Mixed dry recyclable materials from domestic and commercial |
| Input capacity ranges | 1k – 500k tonnes per annum |
| Typical outputs | Recyclate, aggregate, RDF |
| Purpose | To separate different recyclate streams by material and then by grade (where appropriate) ready for sale to reprocessors and the material commodities market |
| Indicative capital cost | c. R 46.5m – R 77.5m for a 25ktpa clean MRF |

Table 5: Key characteristics of clean MRFs

A clean MRF will typically handle **metallic and plastic containers**; however a wider variety of metals and plastics can be separated. Other materials that are suitable for treatment (and separation) by a MRF are **glass, paper and card, cardboard, textiles and waxed cartons**. It is also possible to segregate batteries and small waste electronic and electrical equipment (WEEE) if these are enclosed in coloured containers within the mixed waste stream. This will require specific public engagement and may cause problems for the MRF machinery if not controlled sufficiently.

A typical process flow diagram for a clean MRF is presented in Figure 8.

4.3.3 Preliminary treatment / volume reduction stage

Mixed recycling is input into the process in an untreated form. A series of processes can be undertaken to either remove waste which cannot be treated (oversized items and contamination) or to prepare waste so that it can be accepted by the mechanical technologies at the next stage of the MRF process. Typically, a bag splitter will be used to split bagged waste (if applicable) and a **manual picking line will be used to remove items which cannot be separated mechanically**, for example textiles and electricals. At this early stage of the MRF a simple separation technique (for example trommel or drum separator) will be used to separate materials by property. This will create two or three material streams determined either by size, weight or dimensions (i.e. two dimensional (2D) materials will be separated from three dimensional (3D) materials). A two stream MRF will often have a line for 'flats' (i.e. paper and card) and a line for containers. A three stream MRF will separate two container lines; one for heavier containers (i.e. glass) and one for lighter containers (i.e. plastics and metals).

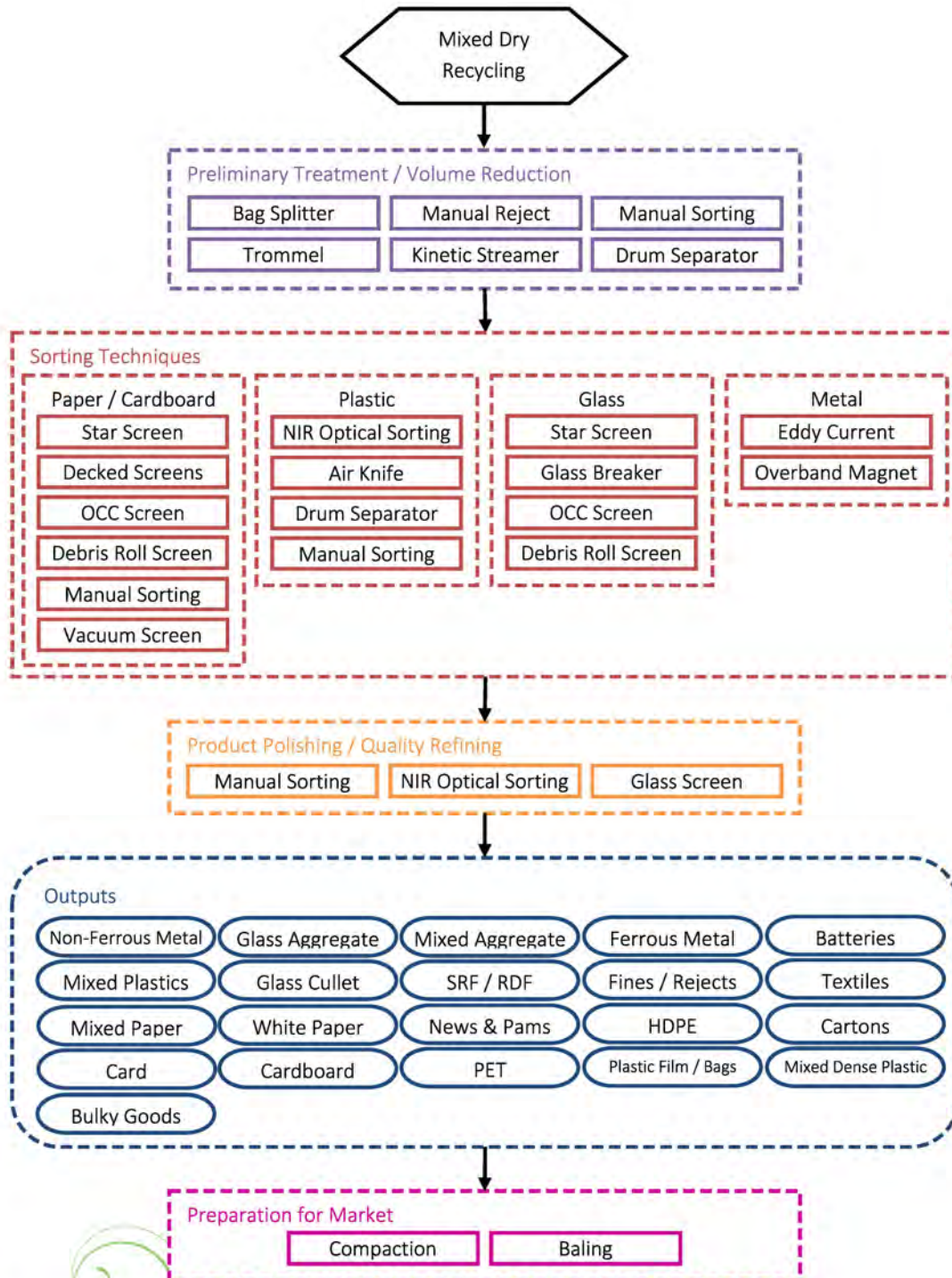


Figure 8: Typical clean MRF process flow diagram

4.3.4 Material sorting techniques stage

At this stage of the process a MRF will have a partially sorted waste stream with a large proportion of non-recyclable materials removed. A number of techniques can be employed to separate specific materials at this stage with a varying degree of complexity dependent upon the target material. Typically a MRF will separate steel through the use of overband magnets and aluminium using eddy currents (relying on applying an electrical charge to the material). These will usually be applied to the 3D stream although can be applied to multiple streams. Glass can be separated on account of its size (for example using a star screen, debris roll screen or OCC screen), often with the assistance of a glass breaker which smashes the glass into manageable pieces. If the MRF accepts **glass and paper combined, the quality of the paper may be compromised by glass shards** and therefore have a reduced market. If the glass fraction is of a high enough quality (usually defined by the size of the glass fragments) it can be sorted by colour using optical sorting equipment at dedicated facilities, although a more common use is as a secondary aggregate.



Figure 9: (clockwise from top left) Mixed recyclable materials in tipping hall (image courtesy of WRAO); manual picking line (image courtesy of WRAP); mixed plastics approaching a NIR sorting machine (image courtesy of Titech); baled separated HDPE plastic bottles (image courtesy of WRAP)

After initial separation, plastics will usually be part of a mixed stream commingled with other containers (i.e. metals and glass). On account of its lower weight and density, air separation techniques can be used to separate the plastic fraction. Once this has been done it is possible to separate dense plastic from light plastics or plastic bottles from mixed plastics, etc., (other configurations are possible dependent on the chosen target plastic stream) using manual picking belts and/or Near Infra-Red (NIR) optical sorting equipment.

Paper can be separated at an early stage using a star screen (or similar technologies) based on its two dimensional nature. The paper will be a mixed grade output at this stage; however it is possible to use either manual sorting or optical sorting (or both) to separate grades of paper/card from the mixed stream. **A typical MRF will separate cardboard from the mixed paper stream, and if practicable will target newspaper (and similar) as a high value product.**

Usually, other target materials will be separated at an earlier stage; however it is possible to extract waste streams, such as cartons and textiles, by manual picking lines after initial splitting of waste streams along physical property lines.

4.3.5 Product polishing / quality refining stage

Some mechanical sorting technologies will separate a product stream with a small amount of contamination. **Further sorting can remove these contaminants** and improve the quality of recyclate produced. This will ultimately lead to a **higher market price** for the materials segregated by an MRF. To remove these contaminants a further sorting process, either through negative manual picking belts or optical sorters, is required. As well as removing contaminants it is possible, at this stage, to refine a material stream, either by targeting a specific product contained in the material stream (e.g. clear PET bottles) or by splitting a material stream by physical properties to form two (or more) more homogenous material streams.

4.3.6 Process outputs

The main outputs from a clean MRF will be separated recyclate. The amount of contaminants within the feedstock material and the separation technology and manpower employed at the MRF will determine the quality and number of material streams produced. **A more intensive process will produce cleaner waste streams with fewer contaminants.** It will also enable the separation of materials streams, for example paper and card, by grade. Typical outputs from a MRF will include, although are not limited to; paper and card, cardboard, mixed glass cullet, PET plastics, HDPE plastics, plastic film, mixed aluminium and mixed steel.

There is a mature and competitive market for recovered metals, particularly for steel and aluminium. The quality of the metals and contamination levels are not usually prohibitive to finding a market for secondary metals, and an income stream can be expected. **Where high quality glass 'cullet' can be recovered, this can be suitable for higher value markets to glass reprocessors and the re-melt industry. Lower value glass can be used for aggregate applications.** Modern MRFs are capable of recovering many different types of plastics to high quality from streams of mixed recyclate. **Where plastics can be separated into different polymer types, a greater market price may be expected; mixed plastics command a lower market price.** For mixed recyclate streams, paper, card and textiles can be separated in a MRF to achieve high quality recyclate. Mature markets exist for these recovered materials and they are likely to generate income where the required quality levels can be delivered.

Rejected materials and contaminants extracted by a MRF can be used to form an RDF suitable for energy recovery facilities. This RDF may include low grade papers sorted by the MRF.

4.3.7 Preparation for market

Mixed and segregated material streams can be prepared for further reprocessing or market using compaction and baling equipment to improve their ease of transport. RDF can also be baled ready for transportation to an energy recovery facility.

Case study: Robinson Deep MRF, Turffontein, Johannesburg Gauteng

Background

Pikitup Johannesburg SOC Limited initiated a pilot 'Separation at Source' project in the Waterval Depot Area in November 2009 targeting 35,000 households. The vision of the Separation at Source team is to 'divert recyclable waste away from landfill' through a **separate dry recycling (i.e. glass, plastic and cans) collection using a clear bag and paper products in a reusable hessian bag** with general waste going in a 240 litre bin. The recyclables are collected by co-operatives and taken to MRFs and recycling facilities. In support of the roll out of the Separation at Source programme the Robinson Deep Material recycling facility has been re-commissioned as a clean MRF.



The 'Separation at Source' pilot programme was expanded to other areas (Zondi, Diepsloot and Orange Farm), and currently serves approximately 265,000 households, collecting 4,970 tonnes/annum of recyclable materials. Pikitup intends extending this service to cover the entire City by June 2014, i.e. all 958,000 households.

Types of waste treated

The Robinson Deep MRF was built in the early '90s and was previously operated as 'dirty' MRF receiving mixed waste and sorting through the 'dirty' mixed waste to recover recyclables. Recovery was inefficient and the demand for the recovered 'contaminated' materials was poor. This operation was not found to be viable and subsequently the facility was closed, **prior to re-commissioning as a clean MRF.**

Equipment used

The MRF is partly mechanical and partly manually operated, recovering recyclables from the general, mixed municipal waste stream. Mechanised conveyors and manual sorters are utilised.

Job Creation

Reclaimers previously hand picking recyclables from landfill sites, will be **provided formal employ in the facility** and removed from hazardous tipping areas. **About 450 jobs** are expected to be created at the Robinson Deep MRF when in full operation. **The reclaimers can be deployed to the MRF to work under better controlled and hygienic conditions.**

It is envisaged that as the City wide roll-out progresses, less and less recyclables will find its way to the landfill. This will also contribute significantly to the reduction of waste that is disposed at the landfill site.

Source

Jeffares & Green Waste Minimisation Strategy, 2014

A select number of municipalities and private contractors in South Africa have established material recovery facilities for separating and sorting clean recyclables collected from a 'separation at source' service for municipal household wastes or collected from the commercial/business sector. The City of Cape Town currently provides a separate co-mingled recyclables collection service to approximately 30% of its residents and Pikitup (Johannesburg) is in the process of rolling out a separation at source programme to all residents across the entire City of Johannesburg. The Kraaifontein Integrated Waste Management Facility (City of Cape Town) has a design capacity of 100 tonnes of commingled recyclables per day and has been operating for approximately three years. Pikitup has opted for a large MRF facility (currently being established at Robinson Deep) with a number of satellite decentralised recycling facilities to be operated by social compacts, i.e. co-operatives, thereby offering more employment opportunities rather than employing mechanized solutions.

4.3.8 Concluding comments

Clean materials recycling facilities will only operate on dry recyclables that have already been segregated from the remaining waste, therefore they are a component alongside a dedicated collection system. They can be low technology, i.e. with a substantial amount of manual picking, or high technology with more capital intense equipment (such as optical sorters). The most likely applications in South Africa would be to utilise manual pickers to help sort the recyclables in conjunction with some mechanical segregation (e.g. magnets). This would have the mutual benefit of reducing capital costs and maximising employment, with the strategic aim of transferring employment from landfill pickers into recycle sorters, with the associated environmental and health and safety improvements.



Case study: Kraaifontein IWWMF, Kraaifontein, Western Cape

Background

The Kraaifontein Integrated Waste Management Facility (KIWMF) built at the cost of **230 million rand** incorporates **waste transfer, public drop-off and waste minimisation facilities alongside a cMRF**, the first of its kind in South-Africa. The KIWMF was designed to be modern and mechanised in order to efficiently and cost-effectively transfer solid waste and recover recyclable waste materials produced by **750,000 Western Cape residents**. In developing its Integrated Waste Management Policy (IWMP) and Plans in 2005/2006, the philosophy of a regional landfill and associated transfer stations was endorsed by the City of Cape Town, following previous recommendations of a satellite transfer station model with centralised treatment points. In April 2007 the City of Cape Town's Solid Waste Management Department commissioned the construction of the IWWMF.



Facility parameters

A key focus for this facility was to move waste management towards a more sustainable municipal service – one that meets new national waste regulatory requirements, reduces waste transportation costs, provides meaningful employment, effectively diverts waste from landfill and enhances the beneficial use of waste. The facility was designed to allow waste to become a resource, and incorporated green initiatives.

Recyclable waste that is received from the City's separation at source/two-bag collection system (for the Oostenberg/Kraaifontein collection catchment area) (**85 tonnes/day**), is sorted, separated, baled and then sold. 1000 tonnes/day of non-hazardous residual waste is accepted at the transfer station / bulking facility. **The KIWMF employs 150 full-time staff.**

Equipment used

The Kraaifontein MRF makes use of mechanical treatment in the form of bag-splitters, disc-screens, glass-breakers, flow-levellers, conveyors, bunkers, bottle-piercers, magnetic separators, compactors and balers. A new type of loading magazine that handles the closed roll-on, roll-off reinforced steel containers, not previously used in RSA, was designed and constructed for the transfer station to allow three containers to be loaded simultaneously per compactor line. These magazines allow live-weighing so that the operator of the facility can see immediately (before the containers are removed) whether the containers have been optimally filled for transporting. The facility allows the integration of activities, to avoid unnecessary (costly) transportation and handling of waste, and to divert waste from landfill, thereby indirectly supporting the growth and employment opportunities in a growing sustainable recycling industry.

Source

www.capetown.gov.za/en/Solidwaste2/pages/newwastemanagementfacilityforkraaifontein.aspx

SAICE Magazine article by Jeffares & Green, December 2012

4.4 Dirty materials recycling facility

A dirty material recycling facility (MRF) differs from a clean MRF in so much as it is **segregating valuable materials from a mixed 'dirty' waste stream** rather than separating the components of an already part segregated 'clean' waste stream. Whereas the majority of material passed through a clean MRF is recycled (with a small portion rejected, or not segregated) **a dirty MRF will typically recycle less than 1/4 of input material**, however experience in South Africa has achieved much less successful rates than this and subsequently plant have to date been unable to generate significant revenue from product sales.

| | |
|-------------------------|--|
| Waste streams accepted | Residual waste, C&I waste, C&D waste |
| Input capacity ranges | 10k – 500k tonnes per annum |
| Typical outputs | RDF, recyclate, aggregate |
| Purpose | To recover recyclables from a mixed solid waste stream and produce an RDF from remaining residuals |
| Indicative capital cost | c. R 62 – R 108.5m for a 50ktpa facility |

Table 6: Key characteristics of dirty MRFs

A dirty MRF may accept mixed solid waste, mixed commercial waste or construction and demolition waste. **Target materials for a dirty MRF will usually include aluminium and steel, and may also include mixed plastics, mixed paper/card, wood, textiles and aggregate/ glass.** The remaining materials may be used to **produce a refuse derived fuel (RDF) for energy recovery facilities.**

A typical process flow diagram for a dirty MRF is shown in Figure 10.

4.4.1 Preliminary treatment / volume reduction stage

Mixed solid waste is input into the process in an untreated form. A series of processes can be undertaken to either remove waste which cannot be treated (oversized and hazardous items) or to remove large recyclables. **At this stage these processes will normally be manual.** Following this manual picking stage waste will be prepared so that it can be accepted by the mechanical technologies at the next stage of the MRF process. Typically, a bag splitter will be used to split bagged waste (if applicable) before shredding of waste ready for preliminary sorting.

4.4.2 Preliminary material sorting stage

The preliminary sorting stage consists of a simple separation technique (for example trommel or drum separator) which will be used to separate material elements of the mixed waste dependent on their physical properties. **This will create two or three material streams determined either by size, weight or dimensions**, usually consisting of a fines/rejects fraction suitable for landfilling or, potentially, energy recovery; a light/large (container) fraction ready for further recovery processes; and a heavy/small fraction ready for alternative recovery treatment processes.

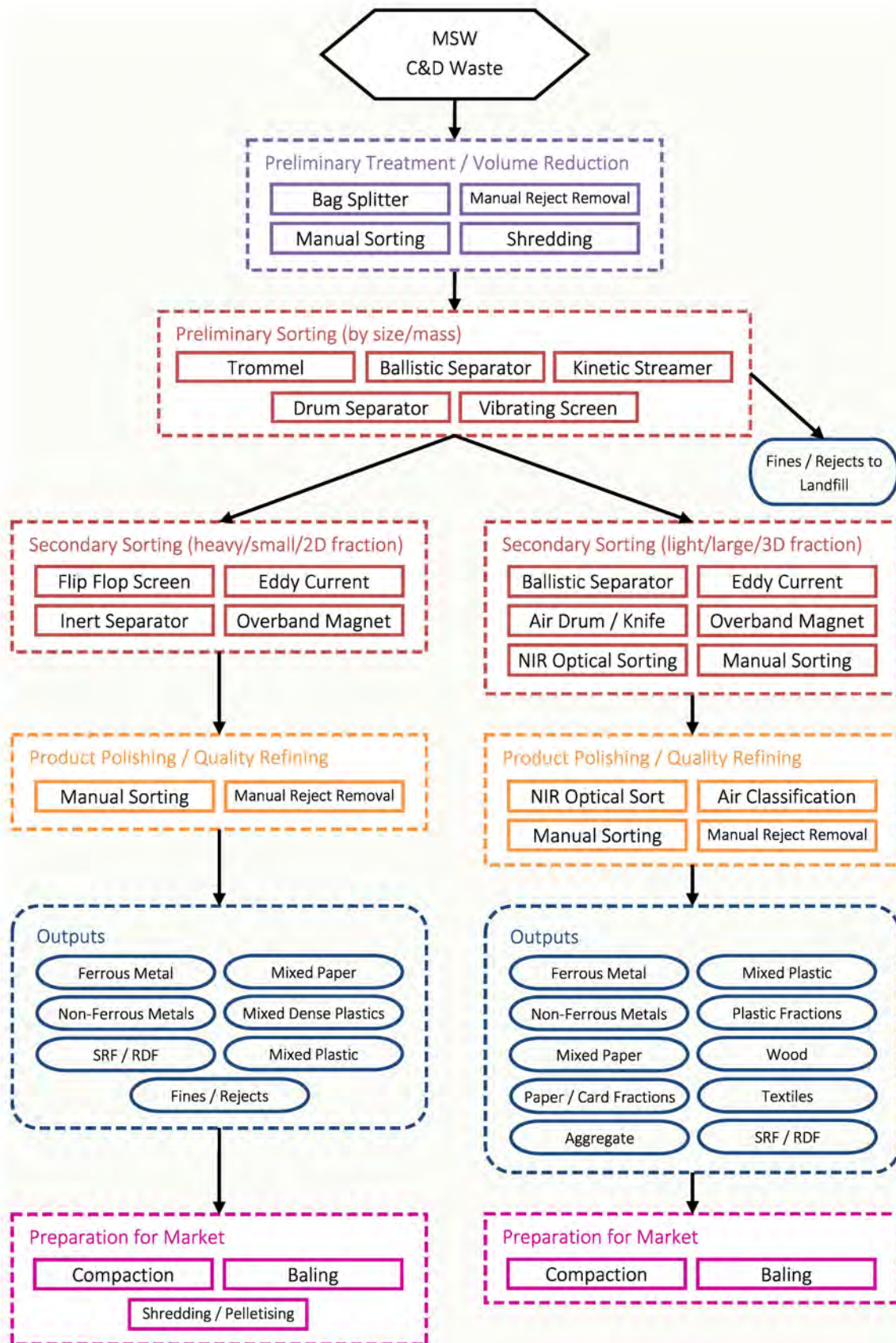


Figure 10: Typical dirty MRF process flow diagram

4.4.3 Secondary material sorting stage

The heavy and light fractions (or similar) separated at the previous sorting stage will be subject to further sorting processes. Specific to the heavy (or 2D) waste stream, a flip flop screen can be used to remove fine contaminants and leave a cleaner stream ready for the mechanical separation techniques. The processes of these two streams will often include similar technologies, and will be tailored on a site by site basis to the specific typical compositions of these streams. Therefore, the technologies discussed in the following paragraph are applicable to both the light and heavy waste fractions.

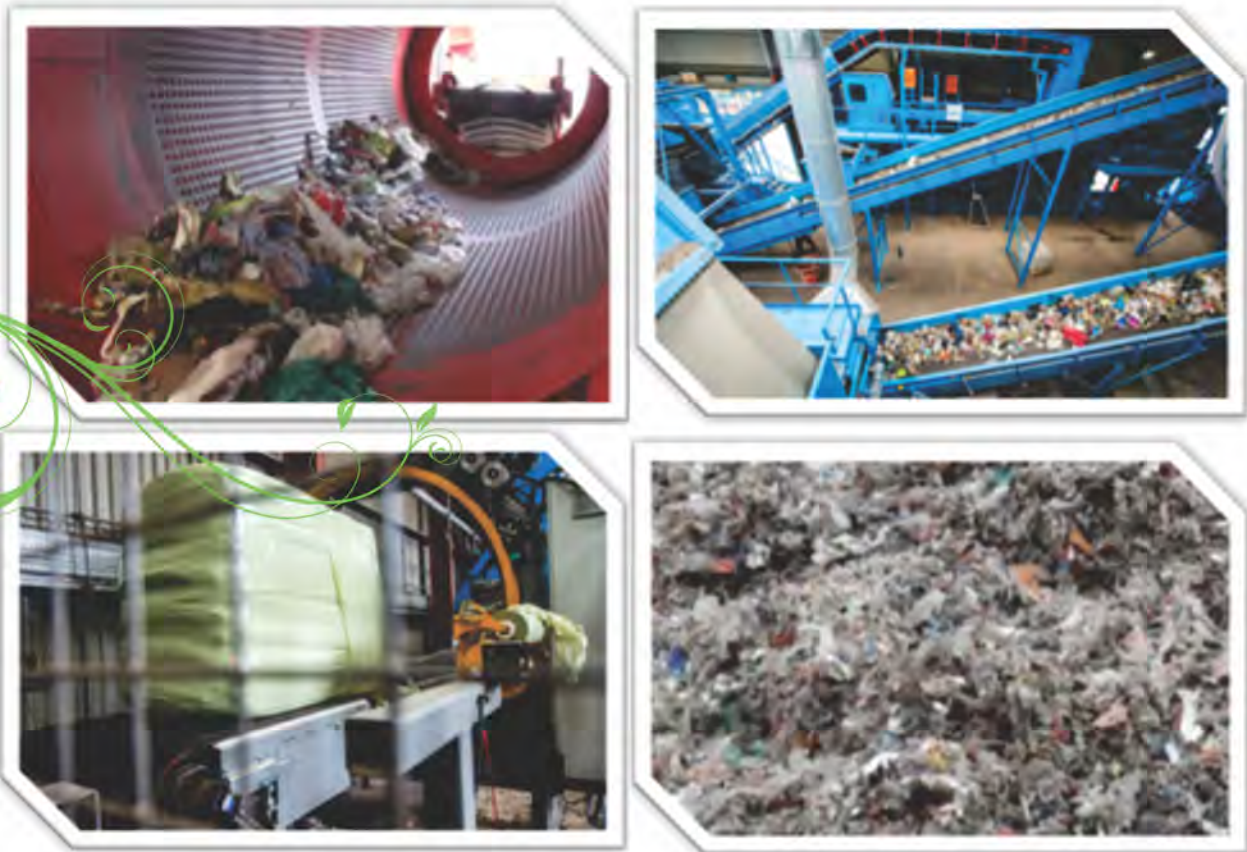


Figure 11: (clockwise from top left) Trommel screen separates fines (image courtesy of Ton Peel Recycling); conveyor belts move partially separated materials between processes (image courtesy of Neales Waste); shredded RDF (image courtesy of Sita); sorted material baled and wrapped ready for reprocessing (image courtesy of Neales Waste)

A number of techniques can be employed to separate specific target materials at this stage with a varying degree of complexity dependent upon the target material. **Typically a dirty MRF will separate steel through the use of overband magnets and aluminium using eddy currents** (relying on applying an electrical charge to the material). Glass and other inert materials can be isolated with an inert separator.

The nature of the light/large (or 3D) waste stream means further segregation techniques are suitable for extra treatment of this waste, and therefore it is likely that greater separation efficiencies can be achieved on this waste stream. A typical dirty MRF may employ manual sorting at this stage, targeting the most identifiable objects present in the waste stream. Other suitable technologies include NIR optical sorting, primarily for plastic separation but also suitable for paper and card; air separation to extract and clean lighter materials (for example plastics and loose paper) ready for further separation by material; and, ballistic separators to separate a container fractions suitable for further separation by material.

4.4.4 *Product polishing / quality refining stage*

Some of the mechanical sorting technologies employed before this stage will separate a product stream with a small amount of contamination suitable for reprocessing into similar products. **Further sorting can remove these contaminants and improve the quality of recyclate produced.** This will ultimately lead to a higher market price for the materials segregated by a dirty MRF. Low quality recyclates extracted for an RDF and inert materials separated for aggregates will not require this further processing stage. To remove these contaminants a further sorting process, either through negative manual picking belts or optical sorters, is required. As well as removing contaminants it is possible, at this stage, to refine a material stream, either by targeting a specific product contained in the material stream (e.g. clear PET bottles) or by splitting a material stream by physical properties to form two (or more) more homogenous material streams.

4.4.5 *Process outputs*

A dirty MRF will recover products suitable for a number of different outlets. High quality recyclate may be extracted suitable for the reprocessing market provided that sufficient technology or separation processes are in place to achieve the required output standard is employed at the facility. These materials may include segregated metals, plastics and paper and card. If it is deemed appropriate, and the waste stream allows, these may be separated by grade. Lower quality recyclables will produce a high calorific value (CV) fuel (RDF) suitable for energy recovery facilities, or aggregate suitable for sale / outlet into the aggregate market.

Fines and other rejects from the process will usually be of a low quality and sent to landfill, however dependent upon the waste composition and further treatment may be suitable for energy recovery as an RDF. Refuse Derived Fuel (RDF) or Solid Recovered Fuel (SRF) from dirty MRFs (and also MBT and MHT processes) can be combusted either in a conventional incinerator or in an advanced thermal treatment plant as a replacement fuel source. Co-combustion may be an option for the generation of power generation or in an industrial application such as cement production. The advantage of co-combustion is that the infrastructure may already be in place; a disadvantage is that the outlet for the fuel is subject to commercial considerations.

According to an official statement of the Cement and Concrete Institute of South Africa (CCISA), the domestic cement industry is faced with high and increasing demand for cement. With this high demand and lack of production capacity, the South African cement industry is looking at expanding their production capacities. Co-processing of RDF in cement production being closely aligned with South African National Policy on the thermal treatment of wastes, and consistent with the principals of the waste hierarchy, there is much potential of the use of RDF as an alternative energy source. As a result, South African cement companies such as Pretoria Portland Cement (PPC), AfriSam (Pty) Ltd and Lafarge, have shown interest in RDF co-processing and are in advanced stages of discussions with the Rustenburg Local Municipality (RLM) in the North West Province, to use MSW RDF in their kilns in the Rustenburg region.

RDF can vary greatly in quality, relatively dry high calorific value products can be combusted directly in energy from waste plant and cement kilns. Lower quality products may not be suitable for this process and will require further, often expensive, treatment (for example bio-drying to reduce moisture content).

Combustion of RDF / SRF would be subject to the emissions limits set out in the National Environmental Management: Air Quality Act (Act 39 of 2004). It is noted that this Act precludes the co-combustion of unsorted municipal waste for cement production, but not RDF.

The South African Government supports renewable energy alternatives and is aligning its new legislation, related to waste management, with a focus on diversion of waste from landfills. This Government support for RDF opportunities is further promoted by the difficulty in developing new landfills and the current national shortage of landfill void space.

4.4.6 Preparation for market

Mixed and segregated material streams can be prepared for further reprocessing or market using compaction and baling equipment to improve their ease of transport. RDF can also be baled ready for transportation to an energy recovery facility.

Several large scale “dirty” waste materials recovery facilities have been in operation throughout South Africa, with the majority have closed down due to their not being viable. The Robinson Deep MRF in Turffontein was originally operated as a dirty MRF, but has since undergone a machinery upgrade and now operates as a clean MRF. **The demand for recovered recyclables focusses more on un-contaminated materials.** Dirty waste recovery has mainly been based on manual systems (to provide job opportunities), often supplemented with mechanical conveyors, balers and trommel screens. The production rates coupled with the low demand for the contaminated recovered materials, has mostly accounted for the demise of these facilities.

4.4.7 Concluding comments

Dirty MRFs comprise of relatively simple technology and systems to extract recyclables from mixed waste and in some instances prepare a fuel from the remaining waste. The technology may be applied to a wide range of waste streams from construction and demolition wastes through to commercial and household wastes. The technology presents an opportunity in South Africa as regards a method of deriving RDF for co-combustion in cement kilns.

Dirty MRFs may provide significant employment through hand sorting and operation of the plant. There is a need to ensure that workers handling mixed wastes are appropriately protected in terms of manual handling injuries and work in appropriately ventilated safe environments.