A Waste Stream Strategy for a Material Recovery Facility in Gauteng Province, South Africa

Jacques Snyman and Chante Stander

***Abstract*—Climate change impacts are only one of a number of environmental impacts derived from solid waste management options. The landfills airspace in the Gauteng Province will be exhausted in less than 8 years. The amount of municipal solid waste generated increases every year due to an increasing GDP. The Gauteng Province's total GDP for 2013 already R 1 194 billion, making the province the single largest contributor to South Africa's GDP with a contribution of 33.8%, despite having only 1.4% of South Africa's land area with a population of was with a population of 12 272 263 (2011). Developing new landfills is not a sustainable option as landfills have been shown to be an important source of greenhouse gas (GHG) emissions.**

The current situation with municipal solid waste disposal in Gauteng is that the waste is disposed of at landfills without any form of separation at source. Informal reclaimers are active on landfills, collecting on average, 20% of recyclable material, which is sold to recycling companies. There is however no sustainable and profitable structure in place for trading in removal and recycling initiatives. Waste stream analysis studies revealed that 43 % of the municipal waste stream consist of dry recyclable material. A further 80% of the wet component (57 %) consists of green waste that can be processed into compost.

There is no fixed approach to the financing of municipal solid waste services at municipal level. Tariff surveys conducted in South Africa revealed that 58% of municipalities relied on user charges for 100% of their income. The equitable share is generally not used as a direct subsidy to the municipal solid waste account. In those cases where it is explicitly used to support services to the poor it is generally provided as a general rebate to the accounts of identified poor households. It should be noted that there is a significant market for recyclables in Gauteng and in South Africa as a whole. This is however currently dominated by the private sector. It is proposed that municipalities can tap into the recycling market as a potential income revenue stream. Municipalities can choose their role, either directly by investing in reclamation infrastructure and selling sorted material to recyclers, or by facilitating small business and industry in an indirect approach. Municipalities should investigate initiatives to encourage recycling such as subsidy schemes, as well as to reduce transport and disposal costs.

To mitigate the anticipated rapid decrease in landfill airspace the study proposes the development of a regional clean material recovery facility (cMRF) to manage all aspects of municipal solid waste recycling within the Gauteng region with the overall objective of creating an effective, efficient and profitable operation.

The methodological approach was to analyze the waste stream required for the MRF, starting with a theoretical background of collection, separation and selling the recyclable

fraction. The theoretical background of this process is the theory of reverse logistics. This theory focuses on reverse streams of materials, in this case, the waste stream, and the stages of the reverse stream. With this theoretical background, the study analyses the current situation with an internal and external analysis. The internal analysis focuses on the amount and composition of the waste stream as well as the processes at the MRF. The external analysis focused on external factors where the municipality does not have an influence. The internal and external analysis culminates in a SWOT analysis and confrontation matrix for developing a strategy in solving the problem.

The successful operation of a MRF depends on three critical factors; a constant collection process of waste, a well-implemented separation at source process and a sustainable material offset contract with recycling companies. It is proposed that the MRF is partly mechanical and partly manually operated,. Reclaimers, previously hand picking recyclables from landfill sites, will be provided with formal employment in the MRF and removed from hazardous tipping areas. About 450 jobs are expected to be created when the MRF is in full operation. It is envisaged that as the strategy is rolled-out, less and less recyclables will find its way to the landfill. This will also contribute significantly to the reduction of waste that is disposed of at landfill sites, thereby prolonging the landfill lifespan.

***Keywords*— Landfill, material recovery facility, municipal solid waste, recyclables**

I. Introduction

The landfill airspace in the Gauteng Province (GP) will be exhausted in less than 10 years. Developing new landfills is not a sustainable, environmentally friendly treatment solution as studies have shown that they are a significant source of greenhouse gas (GHG) emissions. The landfill airspace will very soon run out of capacity, because the amount of waste increases every year due to an increasing GDP.

The current situation with solid waste disposal in GP is that the waste is disposed of at landfills without any form of separation at source. Informal reclaimers are actively involved on these landfills, collecting on average, 20% of recyclable material, which is sold to recycling companies. There is however no sustainable and profitable structure in place for trading in removal and recycling initiatives. Waste stream analysis studies reveal that 43 % of the municipal waste stream consists of dry recyclable material. A further 80% of the wet component (57 %) consists of green waste that can be processed into compost.

Jacques Snyman, Tshwane University of Technology, Pretoria, South Africa.

Chante Stander, Tshwane University of Technology, Pretoria, South Africa

There is no fixed approach to the financing of solid waste services at municipal level. Tariff surveys conducted in South Africa reveal that, 58% of municipalities relied on user charges for 100% of their income. The equitable share is not widely used as a direct subsidy to the solid waste account. In cases where it is explicitly used to support services to the poor it is typically provided as a general rebate to the accounts of identified indigent households in municipalities.

It should be noted that there is a significant market for recyclables in GP overall and in South Africa as a whole. This market is however currently dominated by the private sector. It is proposed that Municipalities tap into the recycling market as a potential income revenue stream. Municipalities can choose their role, by either directly investing in reclamation infrastructure and selling sorted material to recyclers, or by facilitating waste management in small business and industry in an indirect approach. Municipalities may be incentivised to provide the raw waste free of charge, as an implicit subsidy to encourage recycling, as well as to reduce transport and disposal costs.

To mitigate the anticipated rapid decrease in landfill airspace the study proposes the development of a regional clean materials recovery facility (cMRF) to manage all aspects of solid waste recycling within the Gauteng region with the overall objective of creating an effective, efficient and profitable operation.

MSW management is described by Tchobanoglous & Kreith (2002:1.8) and Williams (2005) as the selection and application of suitable techniques, technologies and management programmes to achieve specific MSW processing objectives and goals. Tchobanoglous & Kreith (2002:1.12) suggest the implementation of a typical MSW management model as illustrated in Figure 1. They further suggest that, to achieve an integrated strategy for handling MSW, an optimisation analysis combining all available options should be undertaken.

Instead of concentrating on the collection, storage and disposal components of the MSW management system, more attention should be paid to the avoidance of MSW as a priority in South Africa (DEAT, S.n.:2).

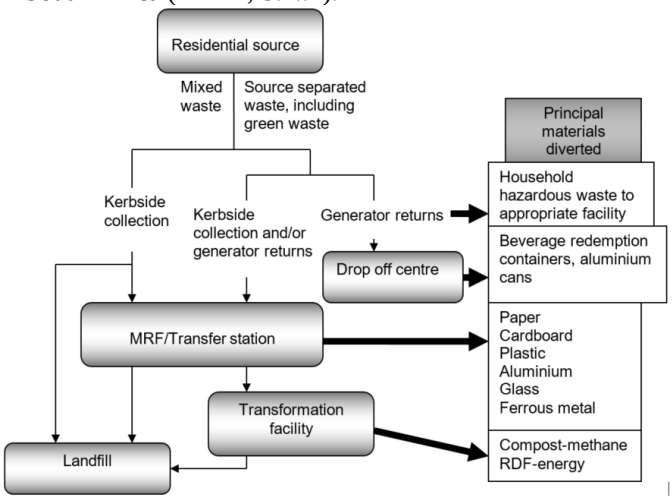

Fig. 1: Typical MSW management model

II. Methodology

The methodological approach adopted in the study, was to analyse the waste stream required for the MRF, starting with a theoretical background of collection, separation and selling of the recyclable fraction. The theoretical background of this process is grounded in the theory of reverse logistics. This theory focuses on reverse streams of materials, in this case, the waste stream, and the stages of the reverse stream. With this theoretical background, the study analyses the current situation with an internal and external analysis. The internal analysis focuses on the amount and composition of the waste stream as well as the processes at the MRF. The external analysis focused on external factors that the municipality does not have an influence on. The internal and external analysis culminates in a SWOT analysis and confrontation matrix for developing a strategy in solving the problem.

The successful operation of a MRF depends on three critical factors; a constant waste collection process, a well-implemented separation process at the MRF and a sustainable materials offset contract with recycling companies. It is proposed that the MRF is partly mechanical and partly manually operated, recovering recyclables from the general, mixed municipal waste stream. Reclaimers, previously hand picking recyclables from landfill sites, will be provided with formal employment in the MRF and removed from hazardous tipping areas. Approximately 450 jobs are expected to be created when the MRF is in full operation. It is envisaged that as the strategy is rolled-out, less and less recyclables will find its way to the landfill. This will also contribute significantly to the reduction of waste that is disposed of at landfill sites, thereby prolonging the landfill lifespan.

III. Status Of Materials Flow In Gauteng Province

The MSW stream composition in South Africa is influenced by income level, geographical location and seasonal differences. The waste stream of the higher income areas tend to have larger proportions of paper, plastics and organics while the waste stream of the low income (developing) areas contains high levels of ash, contained in the residual fraction. The reason for this is that coal and wood fires is the preferred and most affordable method for heating in lower income areas. It should be realized that the data available is on volumes and consequently are incomplete and inconsistent resulting in discrepancies. One however is of the opinion that an informed conclusion can be drawn when averaging of the presented data.

For MSW to be appropriately managed, its composition and the associated risk that it poses must be fully understood. It is recognised that one of the main problems facing GP today is the management of MSW in informal settlements. Figure 2 summarizes the composition of the MSW stream for the more affluent areas as compared to the informal settlements in GP.

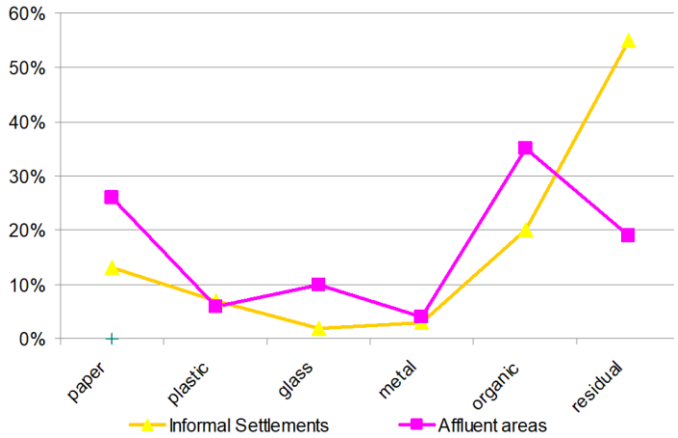

Fig. 2: Comparison of the average MSW composition between affluent areas and informal settlements in GP.

It is evident throughout that the plastic, glass and metal fractions are fairly constant. However, there are variations particularly in the organic and the residual fractions. The probable reason for the variation is due to the fact that methodologies applied in evaluation of the results vary. Typically, a waste steam analysis is conducted only on a weekly curbside collection from households, and bulk collection from informal settlements is not included. The motive for this could be that analysis is generally conducted to determine the economic feasibility of the recycling of certain fractions. It is generally acknowledged that the MSW fraction collected from informal settlements is not financially viable to be recycled.

IV. Evaluating And Prioritising The Key Aspects And Technologies To Be Incorporated Into A Materials Recovery Facility Strategy

In the study various possible realistic and sustainable scenarios for implementation a MRF strategy were evaluated with some options being more ambitious and challenging than others. It was concluded that the MSW stream is separated into only two fractions: a wet fraction and a dry fraction. The motivation for proposing wet and dry separation is due to the reported success with the method. These two fractions are then collected separately at source (curbside), on a weekly basis and taken to MRFs where permanent jobs will also be created to separate the dry materials such as paper, plastic, glass and metal. A waste characterization study conducted indicated that more than 50% of waste will be recycled in this way. The proposed scenario is illustrated in Figure 3

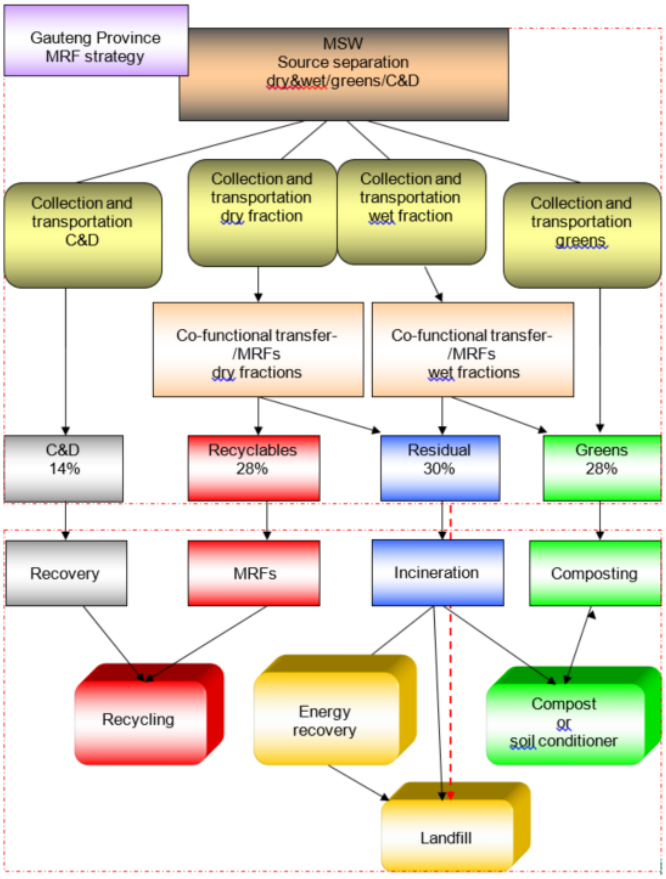

Fig. 3. Material Recovery Facility Strategy

This approach segregates the MSW stream into only two fractions: a wet fraction containing all biodegradable material such as kitchen waste, pet waste and sweepings, greens, non-recyclable packaging and wasted paper and a dry fraction containing materials destined for recycling. Items destined for disposal may however be directed to either stream depending on whether recyclables or compostables are emphasized. It should be noted that to operate an effective source separation programme for MSW composting, contaminants must be directed to the dry fraction. This system, because of its simplicity, in terms of introduction and collection, is to be recommended for implementation at GP and could be refined over the long term. The following options could be considered: The recyclable fractions shall be collectively placed in a separate closed bag at the top of the 240ℓ wheelie bins. The municipalities in GP will then empty the bins and collect the material for processing. The alternative is that the recycled fraction be placed, next to the wet fraction in the wheelie bin, for collection by private collectors. It is however recognised, that there is no evidence that the latter proposal has been tested for sustainability nor that it has been implemented. It can be concluded that such an exercise will allow for a smooth transition to total dry and wet separation therefore it should be an option that is investigated for its effectiveness.

V. Conclusion

While it is appreciated that the affordability of developing

and operating the proposed facilities and the burden placed upon the ratepayers will always be questioned, the GP should however encourage residents to participate in MSW minimization and recycling activities in order to contribute to reducing real operational costs which would be of benefit to all stakeholders.

The GP should recognize that, prospective and current schemes do not show profits from recycling. However, the future cost benefit through the extension of the landfills lifespan and reduced cost due to reduced handling volumes, can be used to subsidize recycling and recovery initiatives.

The damage inflicted upon the environment, due to the disposal of untreated MSW, cannot be measured in monetary terms and remains a grave concern. The cost of prevention is not a good approximation of the destruction to the environment, since the correlation between these two variables is not strong enough. The view is that the cost of rehabilitation of the damage caused in the environment is not a good measure of the dysfunction.

Although the appraisal of the current tariff structure of the GP is beyond the scope of this study, the opinion is that the GP should intensively investigate cost recovery practices bearing in mind that cost recovery is fundamental to budgeting when consideration is given to capital intensive processing technologies.

It noted that the best way to eliminate MSW is to design it out of any system in the first place. One however realizes that this endeavor involves a global paradigm shift and that the GP cannot embark on such an action in isolation however small measures can be implemented that could contribute to achieving this paradigm shift. The following conclusive results were obtained. Regarding the establishment of MRF's, to separate the received dry fraction for discarding to recyclers – results indicate that this hypothesis can therefore be accepted. There is a need to conduct waste stream analysis over a longer period of time to evaluate possible changes is in the composition thereof, and further, to detect changes in the disposal behaviour of residents. It is also recommended that frequent intermediate analysis be performed to verify, and or update waste stream composition data and gather diversion data from GP Waste operations. There is a need to evaluate whether PAYT systems designed as a tool to increase waste separation, recycling, and waste minimization, and enforcement efforts are achieving desired results in terms of modifying MSW disposal behavior.

Some analysis should be conducted to make the collection system of the municipalities in the GP more efficient and cost effective through better routing and collection frequency adjustments.

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J. Snyman holds a Doctor Technologiae (Civil Engineering) degree. He is a registered Civil Engineering Technologist, an Associate Professor and the Head of Department: Civil Engineering at the Tshwane University of Technology, South Africa. His lecturing experience spans over 29 years and he has published extensively on topics in the fields of Water Resource Management and Solid Waste Management.

C. Stander

Graduated in 2018 from the University of Pretoria and received her bachelor's degree in Industrial Engineering. Chanté conducted her final year project on evaluating the optimal method of waste diversion for the City of Johannesburg. Chanté is currently busy completing her Master's degree in Industrial engineering with the topic; A Model for Organic Waste Diversion: A City of Tshwane Case Study.

Chanté is working at Delta Built Environment Consultants, leading the Waste Management Department. Chanté has a good understanding of South Africa's environmental legislation, specifically pertaining to the waste industry. She has experience in conducting waste management related feasibility studies, undertaking socio-economic impact assessments, developing integrated waste management strategies, undertaking candidate site selection for landfills, undertaking feasibility studies for waste facilities such as Material Recovery Facilities (MRFs) and landfills and in managing recycling campaigns