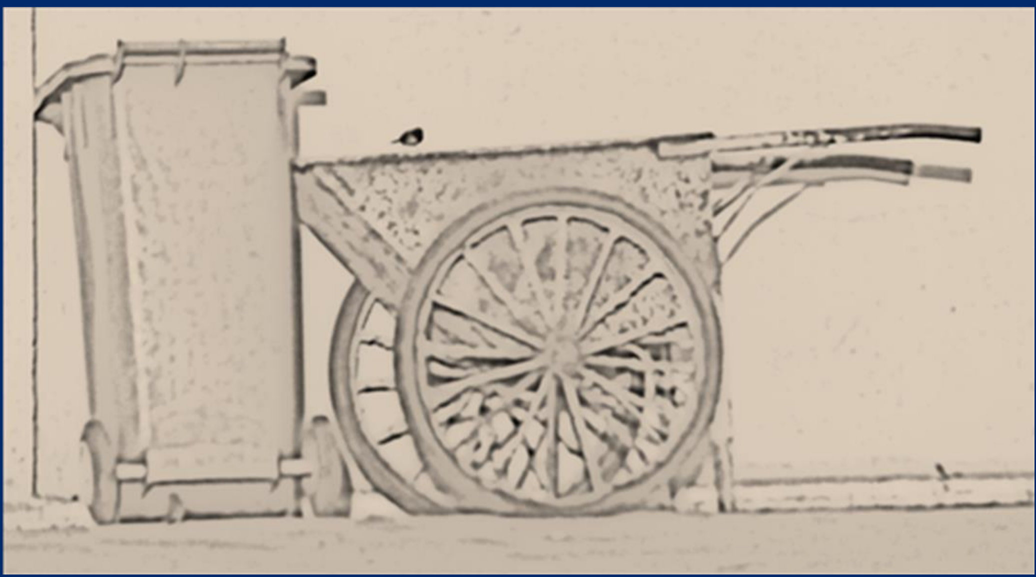
ASIAN DEVELOPMENT BANK

TA-8566 REG: Mainstreaming Integrated Solid Waste Management in Asia

Integrated Solid Waste Management Plan Quezon City



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Contents

Executive Summary

The Integrated SWM (ISWM) Plan is a document that causes City staff and advisors to consider waste management from cradle to grave and review current activities, as well as look into the future for alternatives and opportunities to improve the system overall. Success of the Plan depends upon understanding the development context and implementation priorities and responsibilities. Guidance is provided in the initial Plan chapters on how this should be done in a structured manner. This includes guidance on issues such as formation of appropriate SWM committees and even Boards in larger facilities.

The nexus between the various stakeholders including the political arm of the municipality, their technical staff, private sector organizations involved in any facet of Waste Management and civil society is addressed in the Plan. This even extends to the issue of information, education and communication Plans to maximize Plan effectiveness not only for the initial implementation but during the entire life cycle of the Plan.

Initial sections of the Plan provide an overview of SWM at present within the municipality. For example in some cities it is a partnership between the central city and the various sub-elements such as Barangays in the Philippines. This section of the Plan describes the current status and relationship between the various stakeholders in the municipality, relating to all stages of Waste Management from generation through to disposal. The Plan provides data on the physical assets such as the waste haulage trucks if the haulage responsibilities remain with the municipality rather than being outsourced. Similarly a short description is provided on the waste disposal facility.

Understanding the legislative environment is critical to preparing a future Plan for Waste Management. This is typically divided into three levels of government, namely national or central, provincial or regional and finally municipal. In many cases, the most relevant legislation is a combination of national and municipal. Quezon City however also responds to the Metro Manila Development Authority requirements.

It is important to understand the historical context for the city or municipality. This background is provided in the municipal profile chapters. Geophysical information is also provided relating to the geographical location and boundaries, overview of population, land area and topography as well as climatological data.

All aspects of ISWM Plans are predicated on a sound knowledge of the waste components and quantity that needs to be managed. These waste data are essential not only for the sizing and design of the infrastructure requirements, but also allow the social elements be better understood in terms of assistance required to increase recycling activities and other recovery operations. It was initially expected that site specific waste audits would need to be conducted. However, recent waste audits have been conducted within the city or in nearby municipalities that were of a sufficient standard to ensure that the SWM Plan would still be based on appropriate data sets.

Waste to energy facilities are being considered for Quezon City. Waste to energy facilities may be sensitive to the calorific or heating value of the waste stream, and therefore specialist audits including chemical analysis are usually required to support these waste diversion proposals. However research of available specialist waste audits required for these facilities indicated that there were sufficient audit data available to support the Plan and also the subsequent feasibility studies.

The only waste audit that is to be undertaken is to determine the mass of waste going to the landfill each day. The Payatas controlled dumpsite and landfill is not equipped with a weighbridge and therefore a three day audit is proposed to weigh every vehicle going to the site, both full and empty. There are many estimates available from numerous sources on what this daily waste quantity may be, but given that this is the largest city in the project and will be focusing on a waste to energy facility, then having robust waste mass data was considered essential. This weighing exercise will be carried out in late September or early October.

Waste Minimisation is a key component of overall SWM interventions. The Plan provides background information and a number of options including various legislative opportunities as well as noting the relevance of information and education campaigns. Some of the interventions particularly relate to plastic bags and plastic beverage containers. This section also mentions household hazardous waste which based on the audit results to date that indicated HHW is not a major problem but still requires ongoing monitoring. The city has a collection service for selected HHW such as old fluorescent tubes and batteries.

Quezon City has ordinances where only plastic bags without handles are allowed for packaging of wet goods such as meat and seafood at the wet markets. However this plastic bag is then placed within either a reusable fabric bag or a paper bag as the main carrying implement.

The existing recycling facilities have been reviewed, including the local recycling centres and smaller junk shops. This review is primarily to determine the causative factors limiting recycling quantities at present. An outcome of this section is to list the issues currently limiting recycling and provide a program for improving recycling where appropriate.

The ISWM Plan notes that composting can occur at three different levels, namely household, community or centrally. Many examples are provided both in the text of the Plan and also in the appendices on the advantages and disadvantages of composting organics at these three levels. The default position is that household based composting should be supported and that greenwaste wherever possible should be segregated for chipping and mulching or giving back to the community for gardening mulch.

Estimates have been made for both the future population and waste generation rates for a 30 year period. It is recognised that significant error bands must be placed around these projections however it does provide a guide to ensuring that any new waste facilities, especially landfill sites, are suitably sized to avoid having to find new sites on a frequent basis. It was estimated that the Payatas site had more than 5 years life which should be sufficient to have the waste to energy facility implemented.

Collection services in Quezon City have been privatized for many years, and at present is divided into six separate districts bid separately to ensure dynamic competition. Discussions were held on why this was bid annually as it will be better to have a longer term contract to allow private sector operators to invest in more efficient compactor style vehicles.

Payatas landfill serves Quezon City and the operation has been privatized for over a decade. It continues to be well operated and maintained.

Guidance is provided in the Plan on the management of specific waste types such as difficult wastes, sometimes acceptable waste and prohibited wastes. This includes wastes such as hospital or medical waste, liquid waste and specifics such as asbestos.

All successful integrated SWM Plans involve a component related to information and education, particularly if sustainability is a key city focus. A number of typical IEC components are presented together with a possible approach including community training elements. The importance of the correct communications strategy is also addressed together with options and opportunities for the implementation of such a program. This includes aspects such as radio, television or community outreach through contracted NGOs, and through to mainstreaming through a school's curriculum program. The city currently has extensive IEC activities through all media outlets and will remain a key focus for the city.

Climate change issues are addressed and the review notes potential climate change impacts on SWM as well as climate change adaptation and mitigation steps to be considered.

There is no benefit in providing large capital interventions unless these are operated efficiently and effectively. Therefore guidance is provided on appropriate evaluation and diagnostic tools to ensure that the municipality is maximizing returns on their capital interventions, be it financial or human capital.

In summary, this city is well advanced in terms of overall SWM planning and implementation, including having privatized its collection activities and are very active in the IEC space. The city already has a current SWM Plan prepared in accordance with the DENR requirements. The plan prepared under this project includes other aspects to yield a more rounded document.

City Project

The proposed project is a waste to energy facility with a capacity between 1000 of 1700 tonnes per day. The exact size is yet to be resolved and will be confirmed as part of the feasibility study following the completion of the tonnage audit.

Many discussions were held about the best method of awarding this contract to a private operator. Unsolicited proposals have been mooted over recent years, with discussions on going with French and Japanese organizations as well as local major companies. The TA team has consistently indicated to the city that a WtE proposal is not really a new technology or application and that is a requirement to make an unsolicited bid legal under local legislation.

At the time of writing this report, the city still has not received a formal unsolicited bid. Based on meetings with the Mayor, he would prefer to await the results of the RETA investigation and ongoing support in terms of advising the best way forward for packaging this large project. The city has been reminded that this will be the largest PPP contract to be undertaken by a municipality in the Philippines and as such will receive close attention by numerous parties. Therefore the WTE facility must be packaged and awarded strictly in accordance with the legislative requirements, or else face a deluge of legal challenges including temporary restraining orders.

At this stage there are two main issues of concern (apart from proceeding with a traditional bidding process and not an unsolicited bid) which are land availability and guaranteeing the termination payout provisions.

The city is still attempting to purchase a suitable 10 hectare site but the preferred site located close to the Payatas landfill is the subject of title disputes between various parties. Attempts to resolve this ownership issue have been ongoing for many months and may take years to finally conclude, if ever. Assuming that eminent domain provisions are ineffective, as they appear to be based on the initial legal investigations, it was decided that the private sector proponents would have to provide their own land as part of their tenders rather than relying on the city to provide a suitable site.

The second major issue is that the termination provisions within the contract or concession agreement will require the city to pay out the capital value of the facility if the city decides to terminate for whatever reason. If this occurs, penalty costs may well exceed US$300M. The TA team has developed a number of options for how this may be addressed and will be explored in more detail in the Pre-Feasibility study. One option given that the city is debt free would be to annually earmark part of the internal revenue allotment such that the city would have access to loans monies sufficient to cover the termination costs. How this portion of the IRA could be legally ring-fenced to guarantee future access to the associated credit line will be further investigated.

1. Introduction

1.1. What is an ISWM Plan

The Integrated Solid Waste Management (ISWM) Plan is a document that causes Municipal staff and advisors to consider waste management from cradle to grave, review current activities as well as looking into the future for alternatives and opportunities to improve the system overall.

In summary, the ISWM planning process aims to:

a) Ensure the protection of public health and the environment;

b) Utilise environmentally-sound methods that maximise the utilisation of valuable resources and encourage resources conservation and recovery;

c) Set guidelines and targets for solid waste avoidance and volume reduction through source reduction and waste minimisation measures, before collection, treatment and disposal in appropriate and environmentally-sound solid waste management facilities in accordance with ecologically sustainable development principles;

d) Ensure the proper options are considered for segregation, collection, transport, storage, treatment and disposal of solid waste through the formulation and adoption of the best environmental practices in ecological waste management;

e) Consider greater private sector participation in solid waste management;

f) Retain primary enforcement and responsibility of solid waste management with local government units while establishing a cooperative effort among the national government, other local government units, non-government organisations, and the private sector;

g) Encourage cooperation and self-regulation among waste generators through the application of market-based instruments;

h) Institutionalise public participation in the development and implementation of national and local integrated, comprehensive and ecological waste management programs; and

i) Strengthen the integration of ecological solid waste management and resource conservation and recovery topics into the academic curricula and formal and non-formal education in order to promote environmental awareness and action among the citizenry.

In summary, developing the ISWM Plan provides an opportunity to jointly consolidate a new focus on ISWM within the Municipal environment, and use this as a base to incorporate that recent paradigm shift into all future ISWM decisions and operations.

1.2. Development Context for an ISWM Plan

This document provides the details for and structure of a solid Waste Management plan. However the plan cannot be developed and implemented in isolation of political support and civil society engagement. Quezon City have been very proactive in preparing SWM Plans in accordance with local legislative requirements and their current Plan is enclosed as **Appendix B – Quezon City Current 10-Year Solid Waste Development Plan.**

Their current 10-Year Solid Waste Development Plan covers all sectors and addresses problems especially in the enforcement of environmental laws. The thrust of the Plan is waste reduction/diversion through recycling and composting activities in the Barangay level. Waste reduction/diversion will be focused on the residential areas because they contribute the bulk of solid waste generated. The City requires all Barangays or cluster of barangays to put up their own Eco-Centres/MRF. The Waste Management Committee was to be formed and activated in every Barangay. The Committee may form Cooperatives for the program to be self-sustaining. Incentives and awards program shall also be part of the plan to encourage the Barangays to perform well.

These general development activities may be summarized as shown in **Table 1-1**, together with guidance on the lead actor as well as the desired output:

- **Table 1-1 General Document Activities of ISWM Plan**

Nº.	Activity	Actor	Output
1	Convene a Working Group and establish the Solid Waste Management Board (SWMB). These can be part of existing committees or groups.	SWMC and advisors	Problem analysis
2	Ensure the Mayor is involved with the process and gain support for preparing the ISWM Plan	SWMC	Political engagement
3	Prepare city background data summary and present waste management status	Working Group members and advisors	Current status documented
4	Advise SWMB and gain endorsement and agreement on background and status	Working Group members and advisors	Agreement on current status and shortcomings
5	Undertake the waste audit	Working Group members and advisors	Quantified waste composition and waste mass data
6	Develop the integrated ISWM Plan including community engagement and education aspects.	Working Group members and advisors	Structured plan for solid Waste Management
7	Present the ISWM Plan to the ISWMC	Working Group members and advisors	Adopted ISWMP
8	Agree criteria and prioritize projects for implementation	SWMC	Prioritised activities for Plan Implementation
9	Formulate the detailed concept	Working Group members and advisors	Activity definition and costings
10	Conduct community consultation	Working Group members and advisors/SWMC	Engaged, educated and supportive community
11	Final project concept would then be presented to the Mayor and ISWMC	SWMC	Political support for specific project implementation
12	Organize logistics for implementing project and implement	Working Group members and advisors	Basis for project implementation
13	Conduct regular monitoring and inspection during project implementation	Working Group members and advisors	Project implementation understanding
14	Modify future projects based on lessons learned from this implementation	Working Group members and advisors/SWMB	Improved future projects

1.3. Implementation Arrangements for the ISWM Plan

The City is primarily responsible for developing and implementing the ISWM Plan. The main entity for the ongoing implementation of the ISWM Plan is the Municipal ISWM Board guiding the implementing ISWM Board.

City Ordinance SP-1512, S-2015 was enacted to refine the membership of the SWM Board in March 2015.

2. ISWM Plan Background

2.1. Overview of Solid Waste Management Locally

In overview, both community based and door to door collection services are provided for the residents, depending upon their location and accessibility. These facilities are provided by one of six private collection companies.

There are increasing numbers of recycling bins or green waste repository pits throughout the city at present.

The main haulage vehicles are a mix of 6 and 10 wheeler tip trucks, and garbage compactor trucks.

Quezon City's Landfill is located in Payatas within the city boundaries and has operated on the site for over 20 years.

Overall, the collection and disposal of waste is of a high standard for a city with this socio-economic profile.

2.2. Legislative Environment

2.2.1. National

A number of laws and acts pertaining to the disposal of solid waste have been enacted through the years starting from the 1975 Anti-littering Law (PD825).

With the enactment of Republic Act 9003 by the Philippine Congress in 2000 and signed into Law in January 2001, the Ecological Solid Waste Management Act 2000 provided a framework and blue print to holistically improve the management of solid waste. The law provides for the technical, organizational/institutional, education, policy/enforcement and other related aspects in implementing SWM in the country. However after more than 10 years since enactment, there is still much to be desired with the quality of service provided as well as actual compliance to RA 9003. Based on the assessment of the National Solid Waste Management Commission (NSWMC, the following demonstrates the compliance status of the 1,610 LGUs in the country as of 2014:

- Most LGU SWM Boards and Barangay Solid Waste Management Committees created
- 1,057 SWM plans submitted - 65% came from Cities/Municipalities and 7% from the provinces
- Functional Materials Recovery Facilities is 8,656 which is serving 24.5% of all barangays
- 154 LGUs have access to landfills representing 9% of the total LGUs.

The Philippine Development Plan (PDP- 2011 to 2016) Mid-Term update and National Solid Waste Management Committee (NSWMC) Targets include the following:

- Submission of all LGU SWM plans
- Closure of all open and controlled dumpsites
- Increase diversion away from the disposal facilities by 50%
- Increase the % of total LGUs served by landfills

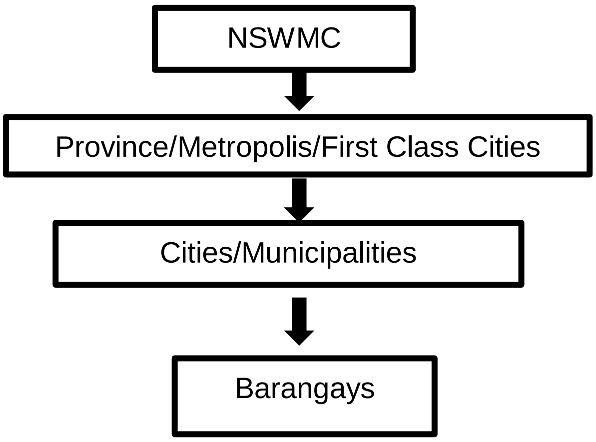
As noted above, RA 9003 is provided with penal provisions, which impose administrative sanctions on local officials for violations of RA 9003. Many implementing department orders, memoranda, and circulars were issued for the effective implementation of RA 9003. However these penal or penalty provisions are rarely effectively used to date.

With the incentive provided by the government through PPP or similar mechanisms, several private entities have invested, constructed and operated SWM facilities including sanitary landfills, commercial scale materials recovery facilities (with some producing Refuse Derived Fuel (RDF)), and commercial composting facilities. The PDP under major Infrastructure interventions to improve environmental quality recommends the development and operation of Waste-to Energy (WtE) facilities and also to revisit the ban on incineration technology.

There are various policies and Acts that have been enacted at the national level, which support the implementation of RA 9003. Some key acts are listed below:

- Republic Act No. 8749 (Clean Air Act of 1999). Among its salient provisions is the prohibition of the use of the incineration method, which is defined as the burning of municipal, biomedical and hazardous waste or the process, which emits poisonous and toxic fumes.
- Republic Act 9513 (Renewable Energy Act of 2008). The Act promotes the development, utilization and commercialization of renewable energy and for other purposes. Section 30 of RA 9513 provides for the use of “waste to energy” technology subject to requirements of RA 9003 and RA 8749 (Clean Air Act). Specifically, waste to energy technology refers to “systems which convert biodegradable material such as but not limited to animal manure or agricultural waste, into useful energy processes such as: anaerobic digestion, fermentation, and gasification, among others, subject to the provisions of the Clean Air Act of 1999 and the Ecological Solid Waste Management Act of 2000”.
- Informal discussions with DENR senior management indicates a possible relaxation of the incineration ban especially if a submission relates to WtE.

The National Solid Waste Management Commission (NSWMC), headed by the Department of Environment and Natural Resources (DENR), heads the implementing body of SWM in the country. The NSWMC was established with fourteen (14) members from the government sector and three (3) members from the private sector. **Figure 2-1** shows the hierarchy of SWM Institutions mandated to implement RA 9003.



- **Figure 2-1 Hierarchy of SWM Institutions under RA 9003**

2.2.2. Provincial

Within the Metro Manila area however, under RA 9003, the Metro Manila Development Authority (MMDA) is mandated to chair its own SWM Board. The LGUs work under the MMDA and directly with residential and commercial generators through the delivery of waste collection and municipal services. The NGOs focus on community-based projects such as environmental education. The scope of MMDA services on SWM involves *"solid waste disposal and management, which includes formulation and implementation of policies, standards, programs and projects for proper sanitary waste disposal*." Accordingly, "*it shall likewise include establishment and operation of sanitary landfill and related facilities and the implementation of other alternative programs intended to reduce, reuse and recycle solid waste*."

However there remains some major issues concerning SWM Implementation in Metro Manila given the role of the Metro Manila Development Authority:

- MMDA's Provincial SWM Board is composed of mayors whose term ends every three years and if not re-elected, comprises new officials every three years (no continuity)
- Disposal facilities remain very limited due to lack of space and local opposition
- Each LGU still effectively "marches to its own beat" politically and operationally
- Lack of communication between the Council and SWM Board

2.2.3. Municipal

A number of local ordinances have been enacted relating to SWM as below:

- Mandates residents, owners, and operators of institutions and establishments to clean their surroundings, including canals, streets, or roads, and their immediate premises to make Quezon City a cleaner and healthier place to live-in; provides penalties for violators.
- Creates the Solid Waste Management Board.
- Amends ordinances #6305, S-65, which prohibits the throwing of any kind of garbage, waste, or any refuse in any drainage outlets such as rivers, creeks, or any tributaries in Quezon City.

- Requires all residents and business establishments in Quezon City to segregate spent fluorescent light bulbs from common garbage so as to eliminate exposure to mercury, an declares such garbage as hazardous waste.
- Adopts guidelines and procedures for a unified approach to Solid Waste Management.
- Gives incentives to barangays practicing best solid waste management.
- Provides incentives to barangays using their own trucks for solid waste collection service in their respective barangays.
- Requires the Barangay Councils of Quezon City to establish and operate ecological recycling and composting centres as part of their respective Solid Waste Management Program before the end of 2001, and as a component thereof, to purchase and operate at least two (2) composting and shredding machines, and mandating that funds be taken from the local government equalization funds and their respective allocation of the waste management fund.

2.3. Institutional Environment

The Environmental Protection and Waste Management Department leads SWM in Quezon City.

The EPWMD is supported by other City departments, such as finance, accounts and legal support for preparing SWM Ordinances.

Solid waste management system in Quezon City can be traced back to the issuance of several laws/orders pertaining to solid waste management. Presidential Decree No. 824 issued on November 7, 1975 created the Metropolitan Manila Area, a geographical unit composed of 4 cities and 13 municipalities (now 16 cities and 1 City). Quezon City is one of the metropolitan cities that formed part of the said geographical unit.

With its creation, Executive Order No. 5 was passed, paving the way for the creation of the Refuse and Environmental Sanitation Centre (RESC), which was later changed to Environmental Sanitation Centre (ESC).

On January 1, 1990, through Executive Order No. 392, the Metropolitan Manila Commission (MMC) was converted into a management-council type organization and was renamed Metro Manila Authority (MMA), with the mayors of the cities/municipalities comprising the Council. Like MMC, it was vested jurisdiction over the delivery of basic services requiring coordination including sanitation and waste management.

The signing of Republic Act No. 7160, otherwise known as the Local Government Code of 1991 paved the way to the enactment of MMA Resolution No.9087 in August 1992. This Resolution turned over the responsibility of garbage collection to the LGUs while disposal operations remained the responsibility of MMA which was later renamed Metro Manila Development Authority (MMDA). This was later reaffirmed with the execution of a Memorandum of Agreement (MOA) between MMDA and the 17 LGUs through Metro Manila Council Resolution No. 01, Series of 1992. This agreement allowed LGUs to have operational control and supervision over solid waste management functions within their respective jurisdiction.

As an off-shoot of the devolution of environmental management functions to the LGU's, Task Force Clean & Green under the Office of the Mayor of Quezon City was created by virtue of Memorandum Order No. 2, Series of 1992. This Task Force took over the responsibility of solid waste management, among others, for the City. It served for nine

(9) years until City Ordinance No. 982, Series of 2000 was passed, creating the Quezon City Environmental Protection and Waste Management Department (QC-EPWMD).

QC-EPWMD is tasked with the following:

- To develop and directly administer a comprehensive environmental protection program which will specifically cover solid waste management and pollution control;
- To maintain and operate a garbage collection and disposal system that conforms to the requirements of environmental laws;
- To enforce all laws, regulations and policies pertaining to environmental management and pollution control;
- To institute a standard monitoring system in the delivery of garbage collection services in the City;
- To formulate civic consciousness programs geared towards environmental sanitation, e.g. cleanliness, proper waste
- segregation, disposal and recycling in the barangays, to be
- implemented in coordination with other non-governmental organizations;
- To establish linkages and coordinate with offices of the City Government and other national and local government agencies for the promotion of environmental management programs and projects in the City;
- To maintain and operate a comprehensive pollution control program to include anti-smoke belching and industrial pollution control;
- To undertake continuing studies and researches on environmental management with the end in view of introducing modern concepts and technologies that can be adopted by the City in the light of existing conditions, regulations and sustainability.

2.4. Previous Studies and Investigations

A large number of previous studies and investigations have been undertaken, ranging through all aspects of SWM from waste minimisation, segregation, recycling, collection, waste processing and final disposal. Included in this long list would be reports such as the 2009 Vision and Mission Booklet describing the role of the EPWMD.

However most directly related to the update of the ISWM Plan would be the 2010 SWM Plan and the Annual Accomplishment report by the EPWMD.

2.5. Proposed Guiding Framework

The current project will build upon the previous work and take it to a level which has community, civil society, commercial and government support for a sustainable project and appurtenant activities.

Whilst the terms of reference provide clear direction for this activity, an umbrella framework is proposed as set out below which brings together the various elements of an eclectic integrated Solid Waste Management plan.

This approach is built upon the UNDP/UNCHS (Habitat)/World Bank/SDC Collaborative Programme on Municipal Solid Waste Management in Low-Income Countries Conceptual Framework, SKAT Working Paper No. 9. This document provides an effective guideline for the goals and overall aim of such a project, taking account of the key political, institutional, social, financial, economic and technical components. The programmatic approach below has been prepared to include a number of key elements and activities which directly reflect the needs of the current project.

Table 2-1 Goals, objectives and Strategic Issues of ISWM Plan

Goals

To promote the health and well-being of the entire urban population	To protect the quality and sustainability of the urban environment	To promote the efficiency and productivity of the urban economy	To generate employment and income

Overall Aim

To establish sustainable MSWM systems which meet the needs of all citizens, including the poor

Strategic Objectives

Political	Institutional	Social	Financial	Economic	Technical
Determine MSWM goals and priorities Define clear roles and jurisdiction for MSWM Establish an effective legal and regulatory frame- work	Devolve responsibility and authority for MSWM to local governments Establish effective municipal institutions for MSWM Introduce appropriate management methods, procedures and service targets Build municipal capacity for MSWM Increase efficiency and through private sector involvement Extend lower cost MSWM service through community participation	Orient MSWM to the real needs of people, including the poor, women & children Encourage proper waste handling patterns by the population Raise people's awareness of MSWM problems and priorities Mobilise community participation in local waste management Protect health and socio-economic security of waste workers	Establish practical and transparent cost accounting and budgeting systems Mobilise adequate capital investment resources Raise sufficient revenues for recurring expenses -ensure adequate O&M Improve the efficiency and reduce costs of MSWM service	Promote economic productivity & development through adequate MSWM service Environmentally sound waste collection, recovery and disposal Ensure long-term economic effective-ness of MSWM systems Promote waste minimisation and material efficiency Generate employment and incomes in waste management	Achieve low life- cycle cost of waste management facilities and equipment Technology that facilitates user and private sector collaboration Ensure that technical systems effectively limit environmental pollution

Strategic Issues

Political	Institutional	Social	Financial	Economic	Technical
Relative priority of collection services in relation to safe waste disposal Priority attributed to waste minimisation -reduction and recovery Meeting the service needs of irregular and illegal settlements Mix of instruments for waste management: regulations, incentives and/or motivations Contribution of ESAs to MSWM policy formulation	Optimal distribution of functions and responsibilities? Devolution of MSWM responsibility in spite of limited local government capacity Involving local governments in system planning and development Responsiveness of waste management to real needs and demands Raising the professional standing of waste managers	Adaptation of waste management services to the needs of poor households and women Effectiveness of awareness building or direct community involvement Equity of MSWM service access to the poor Collaboration with and support of informal waste workers	Failing incentive of local institutions to use available cost accounting methods Use of collected revenues for the intended MSWM purposes Incorporating incentives for cost reduction and efficiency	Trade-off between low-cost waste service and environmental protection Control of industrial and hazardous waste in spite of small, scattered sources Trade-off between efficiency of waste service and employment creation	Coherence of technical systems in spite of differing requirements and decision makers Estimation of life- cycle costs of technical alternatives Appropriate standards for sanitary landfill design and operations

3. City/Municipal Profile

3.1. Background

Quezon City was created on October 12, 1939 by virtue of Commonwealth Act 502. It became the capital of the Philippines with the enactment of Republic Act No. 333 on July 17, 1948. In 1975, Quezon City became part of the larger urban governance scheme that is Metro Manila, with the creation of the Metropolitan Manila Commission by virtue of Presidential Decree 824. On July 24, 1976, then President Ferdinand E, Marcos issued Presidential Decree No. 940, conferring the role of the nation's capital to Metro Manila, hence the name National Capital Region.

President Quezon himself served as the city's first Mayor and he later appointed Tomas Morato to the position. A long line of distinguished Mayors succeeded Morato in the stewardship of the city as follows: Ponciano Bernardo, Nicanor Roxas, Ignacio Santos Diaz, Norberto Amoranto, Adelina Rodriguez, Brigido Simon, Jr., Ishmael Mathay, Jr. and the incumbent Feliciano Belmonte, Jr,

Quezon City is bounded on the North by Caloocan City and San Jose Del Monte, on the South by Pasig, Mandaluyong and San Juan, on the West by Manila, Caloocan, Valenzuela and on the East by Rodriguez, San Mateo and Marikina City.

This strategic location provides stable ground foundation, adequate surface drainage, deep water table, and ample ground water supply. It is an area of moderate slopes and the most common soil type is the hard loam, more popularly known as the adobe which was heavily used in construction in the past.

3.2. Population

The people of Quezon City are of mixed regional origin as they are mostly migrants from different parts of the country. The City's population is the largest in Metro Manila with a total of 2,173,831 based on the census conducted by the National Statistics Office (NSO) on May of 2000. The City Planning and Development Office, on the other hand, have estimated the City's population at 2,487,078 in the year 2005.

Tables 1 & 2 in Appendix B shows the City's population and the 10-year projected population at a growth rate of 1.92 % per annum, giving the estimated population in the city as 3,008,000 in 2016, based on this growth rate compounded.

More than half of the population live in informal settler areas so accurate population data are hard to obtain, especially in years outside the census periods.

3.3. Land Area and Topography

In terms of land area, Quezon City is the second biggest in the country, being next in size to Davao City. The City has a total land area of 16,112.12 hectares, which is approximately 29.6% of the 54,344.29 hectare land area of Metro Manila.

It has four (4) congressional districts comprising of 142 barangays.

The city lies on the Guadalupe plateau which is a relatively high plateau on the northeast corner of the metropolis – between the lowlands of Manila to the southwest and the Marikina River valley to the east. The southern portion is drained by the very narrow San Juan River and its tributaries to Pasig River, while running in the northern portions of the city is the equally narrow Tullahan River.

3.4. Climate

Monthly rainfall averages are as follows and the annual average rainfall is 2,400mm, with the annual evaporation 1,600mm.

The annual relative humidity approximately ranges from 65% to nearly 90%.

4. Waste Audits and Load Determination

4.1. Introduction

All aspects of this ISWM Plan are predicated on a sound knowledge of the waste components and quantity that needs to be managed.

These waste data are essential not only for the sizing and design of the infrastructure requirements, but also allow the social elements be better understood in terms of assistance required to increase recycling activities and other recovery operations.

4.2. Previous Waste Audits

4.2.1. EPWMD Audits

The previous study for the composition of the City's solid wastes was conducted at the viewing deck of the old mound area of the Quezon City Sanitary Landfill for seven (7) days during the second (2nd) quarter of 2013.

Waste samples were gathered from nine (9) identified Cells (Barangay, Main Road, Single/Multiple) and collected by the City Hauling Contractors in accordance with existing collection schedules.

The prescribed format for the data recording was provided by the Environmental Protection and Waste Management Department – Payatas Operations Group (EPWMD-POG) and Metropolitan Manila Development Authority (MMDA).

To enable proper estimation of incoming volume of wastes, the EPWMD-POG and MMDA have a database of all accredited garbage trucks that dispose at the Sanitary Landfill. Volume checkers from EPWMD-POG and MMDA are assigned/stationed at the entry point of the Quezon City Sanitary Landfill daily to estimate and record incoming wastes starting with the first arrival of truck for the day at 4:00 AM to the last one at 5:00 PM.

Waste samples gathered were placed in a 3.5 kilogram container bin and then with the use of a weighing scale, each sample was weighed and recorded. After weighing, the samples were placed on the sorting table and classified into different types of material. Each type of material was again weighed and recorded.

The prescribed format for the data recording of the composition of wastes was provided including the necessary supplies and materials in the study. To ensure proper execution of the process, all personnel involved were properly trained and briefed regarding the procedure of the study.

Waste Density

Waste density per sample area or source of wastes was determined through the actual weighing of wastes collected by the garbage trucks utilized in the identified sample areas/sources of wastes.

A weigh bridge was used to measure the tare weight (without loaded wastes) and the gross weight (with loaded wastes) to compute for the net weight or the actual weight of wastes collected and loaded in the garbage truck.

With the volume of the garbage trucks already determined, through the measurement of the dimensions of the truck conducted prior to the survey period, the densities were computed by dividing the truck's net weight with the truck's volume.

With this, different densities were acquired from the different sectors or sources of wastes, namely, Residential A (High-segregation compliance), Residential B (Low-segregation compliance and High-segregation compliance), and Residential C (with Low-segregation compliance and High-segregation compliance), Commercial, Institutional (Government Offices, Hospitals and Schools), Market and Industrial.

The overall **Waste Density** is the average waste density of the samples or sources of wastes. This was derived by dividing the sum of the densities per sample/source with the number of samples/sources.

Per Capita Generation per Day

The Per Capita Generation per Day was determined by dividing the City's waste generation per day with the City's projected population based on the 2010 census conducted by the National Statistics Office (NSO).

The waste generation per day was computed by adding the average weight of wastes disposed in the Quezon City Sanitary Landfill and the weight of wastes diverted (wastes that were recovered, recycled, etc.) The average weight of wastes disposed was acquired through the actual volume checking conducted during the survey period at the entry point of the disposal facility. Since the City's waste diversion rate during the survey period was estimated to be thirty-nine percent (39%), the average weight of wastes disposed accounts for only sixty-one percent (61%) of the total waste generation per day.

Given this, to acquire the total waste generation per day, the average weight of wastes disposed was divided by 61% to account the weight of diverted wastes or the 39% of the total waste generation per day.

4.2.2. WtE Energy Proponents

Waste Audits including laboratory analysis were conducted by at least two possible WtE proponents in the last two years.

However the results of the audits and analyses are commercial in confidence and are unavailable for public dissemination at this stage. It is understood that at least two proponents are in the process of preparing unsolicited proposals for WtE facilities based on these audits. Therefore it may concluded that the comingled waste is commercially suitable for WtE activities.

4.3. Results of QC EPWMD 2013 Waste Audit

4.3.1. Waste Quantity

The ***average volume*** of wastes disposed at the Quezon City Sanitary Landfill is **6,051 cubic metres per day.** The quantity includes waste collected by the City Contracted Haulers, Quezon City Barangays and accredited Private Contractors in Quezon City

The equivalent in weight of **6,051 cubic metres** volume is **1,609 tonnes per day.** The average weight was derived by multiplying the volume by the overall *waste density* which is 266 kilograms per cubic meter.

The resulting densities for every sample area or source of wastes were derived by dividing the net weight of each garbage truck utilized per sample/source with the volume. The overall **waste density** is **266 kg / m^3** which is the average density of twelve (12) identified sample areas or sources of wastes representing the different areas or sectors.

▪ **Table 4-1 Waste Density of Sample Areas**

Residential A	High Compliance (Bio)	- 354.59 kg / m^3
	High Compliance (Non-bio)	- 183.15 kg / m^3
Residential B	High Compliance (Bio)	- 347.92 kg / m^3
	Low Compliance (Non-bio)	- 268.51 kg / m^3
Residential C	High Compliance (Bio)	- 325.29 kg / m^3
	High Compliance (Non-bio)	- 282.34 kg / m^3
	Low Compliance (Bio)	- 166.42 kg / m^3
	Low Compliance (Non-bio)	- 238.32 kg / m^3
Commercial		- 227.93 kg / m^3
Institutional		- 121.04 kg / m^3
Market		- 347.82 kg / m^3
Industrial		- 329.14 kg / m^3

Per Capita Generation per Day - 0.88 kg/person/day

The Per Capita Generation per Day in this study was derived by dividing the average weight per day of garbage disposed at the Quezon City Sanitary Landfill with the 2013 projected population of the City.

2,639,006.56 kg / day ÷ 2,998,658

= 0.88 kg / person / day

4.3.2. Waste Components

The waste types and relevant percentages are summarized in **Table 4-2.**

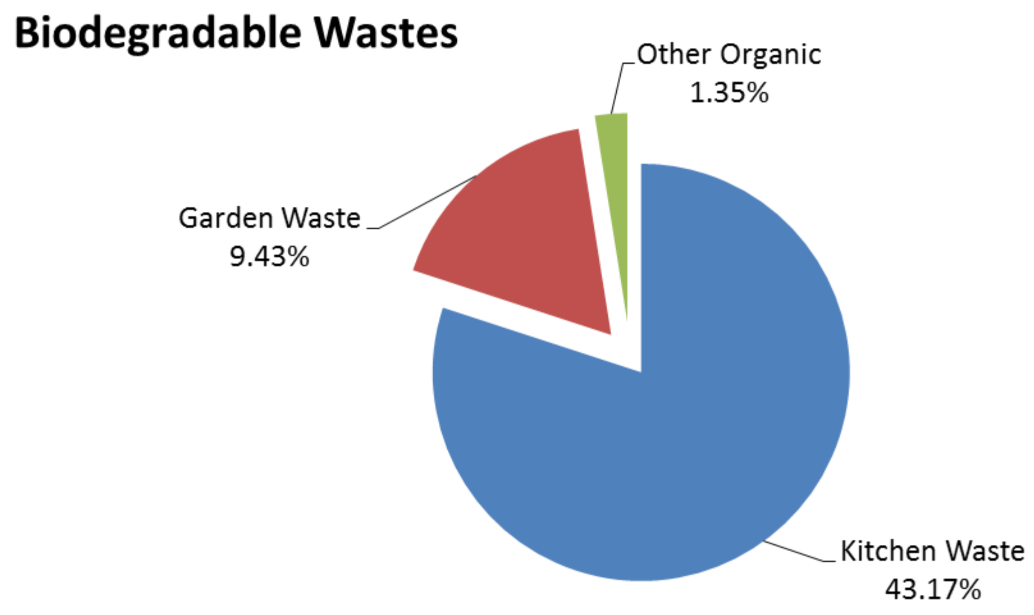
▪ **Table 4-2 Types of Waste and relevant percentages**

Type of Waste	Percentage
Biodegradable	53.95 %
Recyclable	20.30 %
Plastic	9.64 %
Paper	8.65 %
Glass/Bottle	1.15 %
Metals	0.86 %
Residual	25.76 %

Biodegradable wastes have the highest percentage at 53.95%, followed by Residual wastes at 25.76%, and Recyclable materials at 20.30.

As shown in **Figure 4-1** among the Biodegradable wastes, Kitchen or Food waste has the highest percentage at 43.17%, followed by Garden or Yard waste at 9.43%, and Other Organic waste at 1.35%.

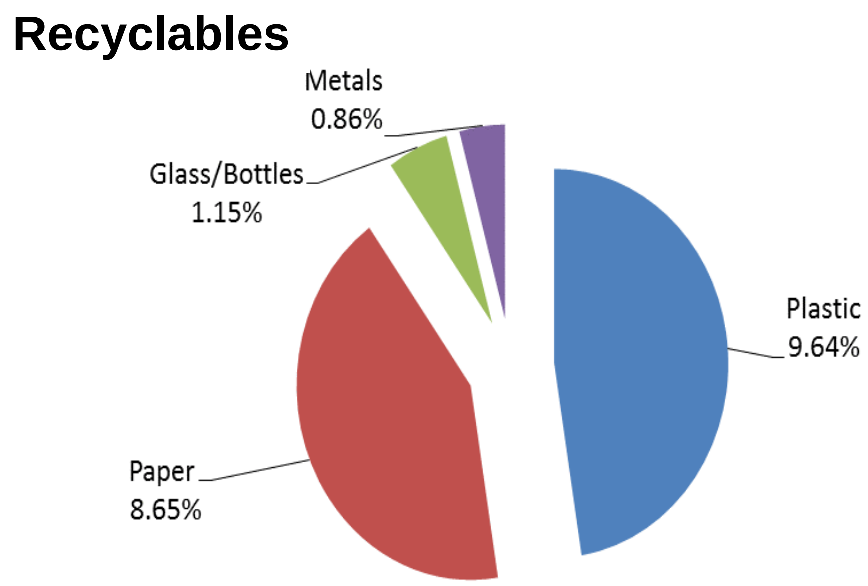
▪ **Figure 4-1 Composition of biodegradable wastes**



Recyclables

As shown in **Figure 4-2** Among the Recyclables, Plastic has the highest percentage at 9.64%, followed by Paper at 8.65%, Glass and Bottles at 1.15% and Metals at 0.86%.

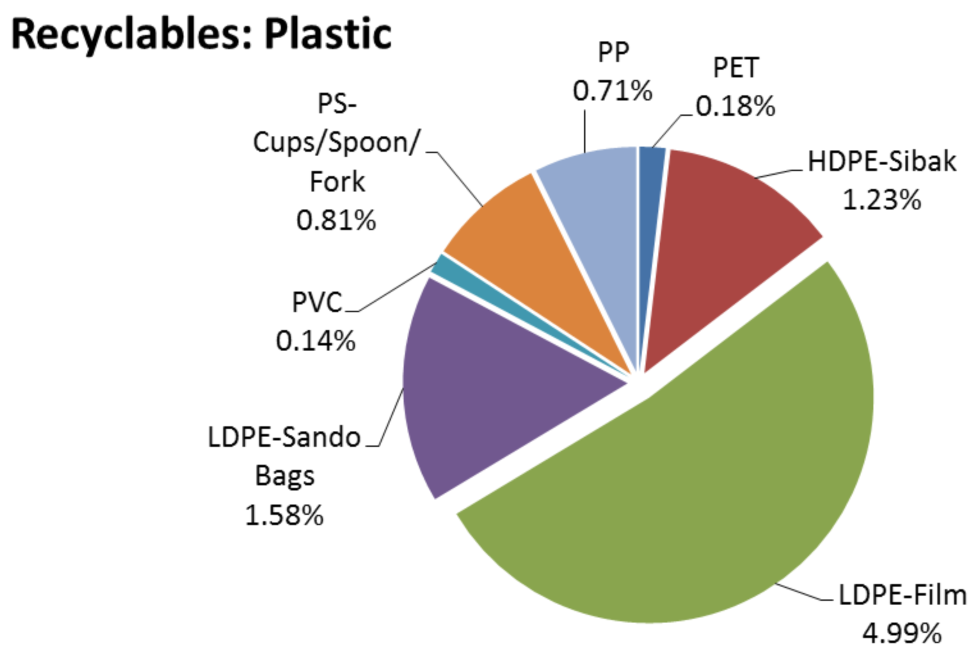
▪ **Figure 4-2 Composition of Recyclables**



Recyclables: Plastic

As shown in **Figure 4-3** among the Plastic wastes under Recyclables, LDPE-Film Plastics have the highest percentage at 4.99%, followed by LDPE Bags at 1.58%, HDPE at 1.23%, PS-Cups/Spoon/Fork at 0.81%, PP-Other Plastic at 0.71%, PET at 0.18%, and PVC at 0.14%.

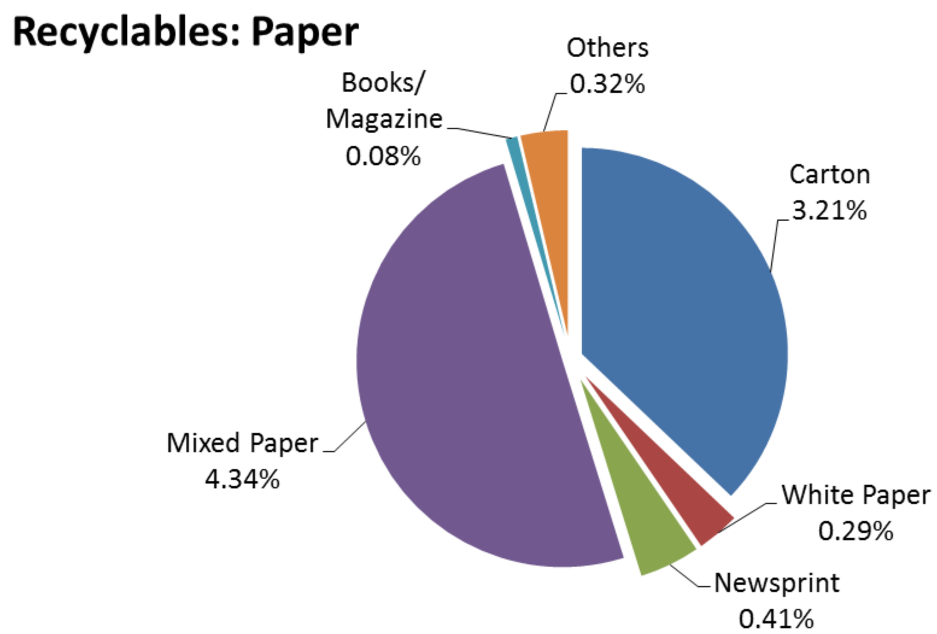
- **Figure 4-3 Composition of Recyclables: Plastic**



Recyclables: Paper

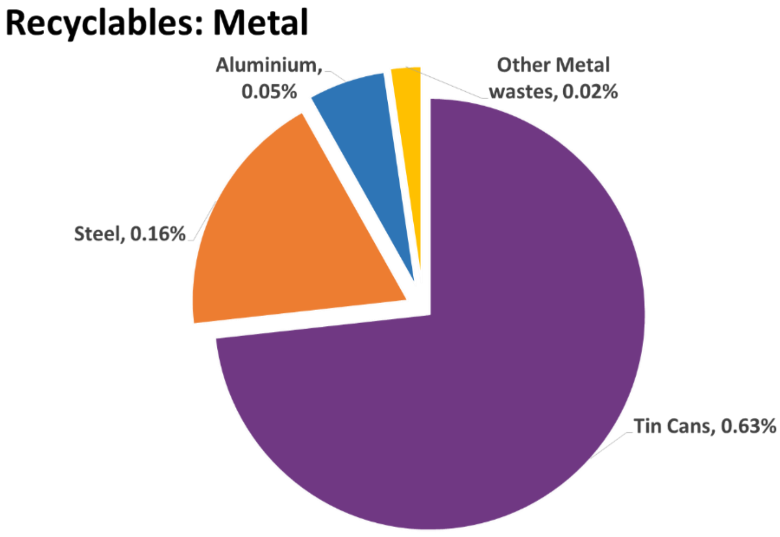
As shown in **Figure 4-4** Among the Paper wastes under Recyclables, Mixed Paper has the highest percentage at 4.34%, followed by Carton at 3.21%, Newsprint at 0.41%, Other Paper wastes at 0.32%, White Paper at 0.29%, and Books/Magazines at 0.08%.

- **Figure 4-4 Composition of Recyclables: Paper**



Recyclables: Metal

- **Figure 4-5 Composition of Recyclables: Metal**

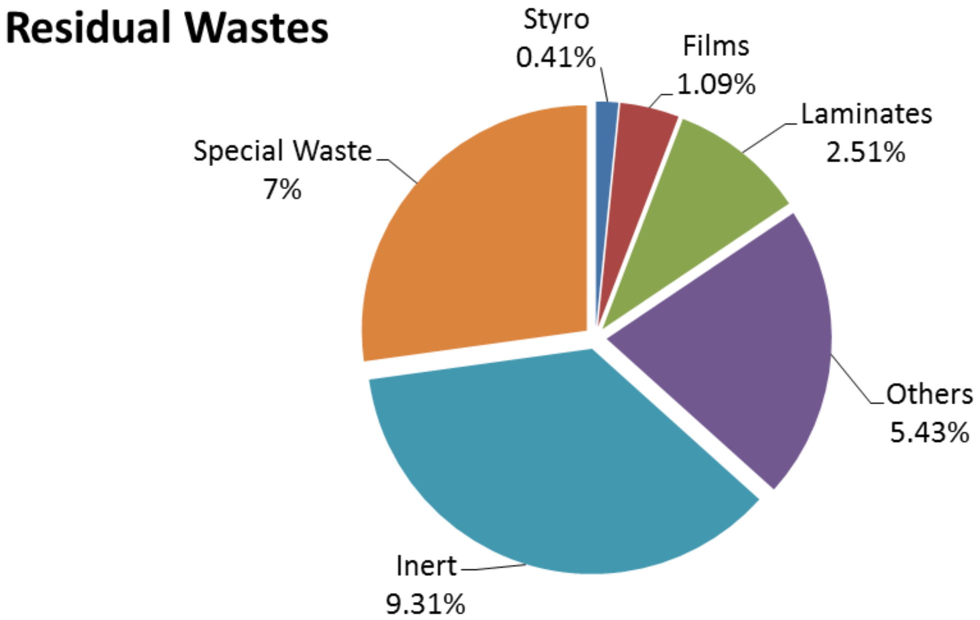


As shown in **Figure 4-5** Among the Metal wastes under Recyclables, Tin Cans have the highest percentage at 0.63%, followed by Steel at 0.16%, Aluminium at 0.05%, and Other Metal wastes at 0.02%.

Residual Wastes

As shown in **Figure 4-6** Among the Residual wastes, Inert waste has the highest percentage at 9.31%, followed by Special waste at 7%, Other Residual waste at 5.43%, Laminates at 2.51%, Films at 1.09%, and Styrofoam at 0.41%.

- **Figure 4-6 Composition of Residual Wastes**



4.4. Project-Specific Audit Results

Waste characterization data of Quezon City was obtained from the Quezon City Environmental Protection & Waste Management Department. The data set is the result of two Waste Analysis Characterization Study which were conducted in December 2015 and March 2016, each lasted for a week. Below are the summary of the key items: Waste generation, MSW composition, Calorific Value, Moisture Content and Chloride Content.

The key items of this study will be compared with the data obtained from a previous project of AECOM in the Philippines (see **Table 4-3 and Table 4-4)**

Putrescible waste accounts for the largest composition in the waste (35.7%), while the plastic content of the MSW is 17%, which is comparatively lower than the proportion in MSW data from other projects (41.8% & 20.4% respectively).

The Gross Heating Value (HHV) of the MSW is 12.001 MJ/kg, which is in line with the HHV of the data obtained from the previous project. Also, it is higher than the required value for incineration and gasification.

The moisture content of the MSW is 42.33%, which is similar with the value of the neighboring countries in South East Asia (around 45%).

The overall chloride content of the MSW is about 0.4176%.

Overall, the MSW in Quezon City has relatively high organic matter and plastic composition, with a high calorific value. By comparing the results of Quezon City with data obtained from previous projects (Commercial in confidence), both sets of data has similar waste composition, having organic matter (35.7% and 41.8 % respectively) and plastics (17.0% and 22.4% respectively) as the component with the largest proportion.

Also, the MSW from both data sets has similar Gross Heating Value as well (about 12 MJ/kg), showing consistent results. The heating value also satisfies the conditions of both incineration and gasification energy production potential Therefore both gasification and incineration would be a viable solution to MSW management.

- **Table 4-3 Philippines Waste Composition Data**

Type of Waste	Waste Composition (%)	HHV (Gross Heating value) (MJ/kg)	LHV (Net Heating Value) (MJ)	Moisture Content (% w/w)	Chloride content (% w/w)
Putrescible Waste	35.7	6.778	4.819	59.85	0.27
Papers	14.4	10.693	8.981	38.11	0.26
Cardboard	3.1	12.309	10.693	30.34	0.16
Complex	4.7	19.967	18.447	12.67	0.23
Fibres	3.0	11.170	9.395	45.93	0.21
Sanitary Fibres	3.7	4.199	1.913	81.24	0.08
Plastics	17.0	27.876	25.703	18.14	1.36
Combustible not classified	14.5	10.287	8.524	44.65	0.19
Glass	1.3	-	-	-	-
Metal	0.8	-	-	-	-
Non Combustibles	1.4	-	-	-	-
Special household waste	0.1	-	-	-	-
Fine elements <8mm	0.4	-	-	-	-
Overall	-	12.001	10.170	42.33	0.4176

- **Table 4-4 Data from previous project experience in the Philippines**

	Percentage (%)	HHV (MJ/Kg)	LHV (MJ/Kg)
Food / Organic Waste	41.8	4.02	
Paper (White)	0.5		
Other Recyclable Paper	1.7		
Non-Recylcable Paper	5	15.88	14.4
Cardboards	1.3		
Textile	4.3	21.61	20.33
All Non-Marketable Plastics	20.4	36.36	33.8
Rubber Tyres	0.5		
PET	0.3		
Other Rigid / Dense Plastics	2	41.84	39.67
Ferrous Metals	0.2		
Other Ferrous Metals	0.7		
Aluminium Waste	0.1		
Other Non-Ferrous Metals	0.1		
Copper Waste	0		
Large Glass Waste	0.7		
Other Glass Waste	2.2		
Leather	1.1		
Rattan & Wood	1.8	18.8	17.34
Inerts	1.9		
Unclassified Waste	5.1	1.77	
Household Hazardous Waste	0.4		
Disposable Nappies	8.1		
Total	100	12.0865	

4.5. Detailed Comparison with other Waste Audits

While a rigorous audit protocol was followed and a large mass of waste sampled, there is still the possibility that the audit results may have been skewed by some external factors. Therefore it is important to compare the audit results with results from not only other parts of the Philippines but internationally as well.

This comparison not only provides some comfort that the local detailed audits are representative, but also provides some comparisons that can be used when deciding a local 3R strategy. For example, if wealthier developing countries have a good 3R market for say glass, then that material should be monitored in the future as it may become a viable commodity for recycling/reuse as the community becomes wealthier and this waste component becomes more prevalent. More details are provided in **Appendix D – International Waste Audit Comparisons.**

- **Table 4-5 Comparison with Other Audit Results**

Waste Type	Quezon City	Afghanistan	East Timor	Philippines	Cambodia	Vietnam	Pakistan
Food Waste	36 - 54	13 - 22	12	9 - 19	19 – 23	15 – 35	10 – 15
Green Waste		10 - 21	33	40 - 54	31– 40	15 - 38	20 – 25
Paper and Cardboard	8 - 14	1 - 8	22	4 - 8	2 – 6	3 – 8	4 – 8
Plastic	10 - 20	11 – 15	18	15 - 17	3 – 15	9 – 16	15 – 18
Textiles	1 - 3	-	2	1 - 3	1 – 4	0.1 –0.9	1 – 4
Glass	1 - 3	2 – 3	2	1 - 3	1 – 8	0.4 –5.0	1 – 3
Metal	.8 - .9	0.02 – 0.95	1	2 - 3	0.6 – 8	0.3 –1.5	1 – 5
Wood	2 - 14		0	0 - 2	-	0.5 – 3	0.5 – 2
Soil and Dirt	.4 - 5	5 - 11	28	10 - 15	10 - 30	10 - 15	15 – 25
Miscellaneous	<25	4 - 12	2 – 10	7 - 14	2 - 8	2 – 12	2 – 10

The results in the above table confirm that the audit results are in line with other local audits and the international data from other developing countries, especially those with similar socio-economic status and weather patterns such as East Timor, Cambodia and Viet Nam.

In general, most of the higher value recyclables are being recovered or reused resulting in very low levels remaining in the waste stream. This includes materials such as glass and metals, especially aluminium and copper.

However, paper and cardboard is a candidate for focused recovery effort. Plastic bags and containers are at a level typical of similar countries, and options exist for a greater recovery rate, especially for plastic drinks containers. However these audits were undertaken before waste pickers accessed the waste at Payatas. So based on the tonnages of recyclables sold per day, and inspection of the waste in place, these materials are being effectively recovered post audit results.

The other major component is the organics, combining both food scraps and greenwaste. Food scraps would have to be segregated at source to be compostable.

Greenwaste is generally mixed with other municipal waste at present and will be very hard to separate economically, unless a separate bin approach described elsewhere is adopted. This would mean that greenwaste will be kept separate and readily available for chipping and reuse.

In summary, there is nothing unusual with the results and the dataset exhibits no obvious outliers, hence these results provide a sound basis for the study going forward.

As a WtE facility is being proposed, most of these components will need to be retained in the waste stream to achieve the calorific requirements in any case.

5. Legal Environment for 3Rs

5.1. Mandatory Solid Waste Diversion

While there are various diversion targets listed in RA9003 and the Implementing Rules and Regulations, such as a minimum of 25% diversion within 5 years of promulgation, Executive Order 774 relating to the Presidential Task Force on Climate Change obligations issued on December 26th 2008 superseded this and requires 50% waste reduction within 6 months of the date of proclamation.

This target has not been revisited since the promulgation date to determine the actual waste minimisation and diversion efficiency being achieved. Local evidence suggests that while QC is making significant efforts and developing various initiatives to reduce waste that there is a limit to how far this can succeed, especially in an environment of increasing community wealth and waste generation. The 2013 waste audit indicated 39% waste diversion which is a laudable effort but is below the very optimistic 50% required by the Executive Order.

5.2. Plans to Exceed Mandatory Diversion Target

Further plans to exceed the mandatory diversion target and address issues being posed by the handling of other waste streams will be determined by the City, in consultation with concerned organisations and groups. This can include, but is not limited to, targeting a higher percentage of solid waste for collection and composting, mobilising generators to implement source reduction strategies to minimise waste generation levels, and implementing holistic recycling campaigns for the other waste streams.

In 2005, QC set the following targets which have not been updated formally since then.

- **Table 5-1 Projected Waste diversion and disposal targets of QC**

Projected Waste Diversion and Disposal Targets Year	Vol of Waste Gen/ Capita/ day with Increase of 2%/ annum based on WACS	Projected Population with 1.92% Growth Rate	Daily Waste Gen Based on Population (ton)	Waste Diversion Target (%)	Volume to be Diverted (ton)	Target Residual (%)	Target Disposal Volume (ton)
2005	0.69	2,392,701	1,651.00	20	330.19	80	1,320.77
2006	0.70	2,438,591	1,716.28	25	429.07	75	1,287.21
2007	0.72	2,485,379	1,784.19	29	517.41	71	1,266.77
2008	0.73	2,533,063	1,854.79	33	612.08	67	1,242.71
2009	0.75	2,581,658	1,928.18	37	713.42	63	1,214.75
2010	0.76	2,631,188	2,004.48	41	821.83	59	1,182.64
2011	0.78	2,681,669	2,083.79	45	937.70	55	1,146.08
2012	0.79	2,733,120	2,166.25	49	1,061.46	51	1,104.78
2013	0.81	2,785,558	2,251.97	53	1,193.54	47	1,058.42
2014	0.82	2,839,003	2,341.08	57	1,334.41	43	1,006.66

By implementing a number initiatives described elsewhere in this Plan, the City was reportedly able to attain a waste diversion rate of 56% from January to December 2015. This is equivalent to 2,737,646 cum. of solid wastes diverted or approximately 171,103 ten-wheeler dump trucks on full capacity. The basis of this calculation would need to be closely audited to confirm such a high diversion rate which appears optimistic.

6. Waste Minimisation Approach

The approach is based on the principles listed in **Appendix E – Source Reduction Policy Options.**

Appendix F – Waste Minimisation for Special Wastes and **Appendix G – Minimisation of Plastic Bags and PET Bottles** also refer**.**

6.1. Integrated Resource Recovery (IRR)

Integrated Resource Recovery (IRR) is the recommended approach to waste management for the City. This aims to *"instil an understanding and support within the community of waste management principles".*

Fundamentally, this can only be achieved by creating the opportunity for members of the public to play an integral and valued role in the decision making process, from initial planning through to system implementation and operation. This has to cover all aspects including resource recovery systems and technology.

It should be developed in three phases, as follows;

- The Strategic Framework – rationale, opportunities, vision, goals, implementation paths, and evaluation of public sector participation
- The Strategy; Why should communities participate in waste management decisions – detailed assessments of international practices in waste management aspects, including analysis of different communication methods
- Principles of Public Participation – Develop rules for the IRR, including roles and responsibilities for the City (elected representatives and staff), National agencies such as civil society, NGO's, industry, Neighbourhood representatives and other interested parties

6.2. Legislation

Waste minimisation legislation has been utilised in many parts of the world in order to control the generation of waste. Examples of such legislation follow.

6.2.1. Container Deposit Legislation (CDL)

Many countries have CDL, including Australia and a number of EU countries and State in the USA. This legislation requires a deposit on containers for products defined as beverages under the Act, with exemptions granted by Regulation. Refunds on containers with deposits are paid at point-of-sale or collection depots and are collected from there for reuse or reprocessing. The primary reason for the introduction of CDL was as a litter-control measure.

However a recent waste industry commission considered CDL as part of its study and found that there was no convincing case for container deposit legislation. The Commission found that deposit schemes are expensive to operate and impose high costs on both producers and consumers and are inefficient compared with other available economic instruments.

CDL operates as a disincentive for the kerb-side collection of recyclables because it lowers the value of the remaining waste stream by lowering the quantities of high-value recyclables such as glass and aluminium.

The degree of success will probably not be too high as there is already very efficient recovery of glass and bottles, first at source by users and by jumper boys in the collection vehicles and scavengers at the dumpsite.

This is addressed further in later chapters relating to PET bottles.

6.2.2. Packaging and Plastic Bag Legislation

In 1991 Germany introduced the "*Ordinance on the Avoidance of Packaging Waste*" (Verpakungsverordnung). This Ordinance was designed to ensure manufacturers take more responsibility for the packaging they create, by giving consumers the right to leave excess packaging behind or return it to the point-of-sale later. As a result, far greater pressure is placed on manufacturing, via retailers, to establish alternative collection schemes and ensure that their packaging is reusable and recyclable.

Two cities in North America, Minneapolis and St Paul, have also enacted ordinances which require that food packaging sold in retail outlets be reusable, recyclable or biodegradable.

Some cities in Metro Manila including Quezon City have simply banned plastic bags except for handle-less bags for wet market purchases. Paper bags or cardboard boxes are supplied instead, or reusable fabric bags are encouraged.

Although this type of legislation is usually enacted at federal or state/provincial government level, it is appropriate that agencies lobby and support the introduction of such legislation.

Another option is the introduction of compulsory charges for all plastic bags used at supermarkets. This has been used in other developing countries such as Fiji in the Pacific. The charge is in the order of 2 US cents per large plastic grocery bag. The aim is twofold:

- Firstly, it is to encourage people to only use the actual number of bags required.
- Secondly, it encourages people to reuse the bags, either for later trips to the supermarket or to use the bags for storing garbage rather than buying special garbage bags and liners. It has also had the effect of people now bringing hessian and other reusable bags to the supermarket and not using many if any plastic bags.

A further option discussed separately below is the mandatory use of biodegradable bags, which is common in both developed and less-developed countries. These are further described in the Appendices.

6.3. Education

A major key in any Government body achieving reduction of waste to disposal is the education of the community, both general society and business. Locally a National Government initiative is required to support education with respect to waste management. This effort could possibly be best directed through a combination of national campaigns, supplemented with funding for local level education through local NGO's.

The USEPA has produced booklets such as "*The Consumers Handbook for Reducing Solid Waste*", 1996. This booklet is particularly comprehensive and addresses the integrated waste management approach, or the cradle to grave approach. This addresses all phases of waste management including advice on reducing the amount of unnecessary packaging. The handbook also covers the issue of adopting practices that reduce waste toxicity, and the associated issue of household hazardous waste collection that is often overlooked in these publications. The composting section is also very basic and provides the details for constructing and operating a household or Neighbourhood level compost scheme.

Also the UNDP funded Project "*Public and Private Sectors Convergence for Solid Waste Co-governance in Urban Poor Communities*" being trialled in Calamba, Philippines would provide good educational material as input to developing a local plan and strategy. These booklets could be used as a basis for developing local educational information.

It is considered that education is the fundamental key to a successful waste reduction strategy.

6.4. Landfill Scavengers

Another method of removing useable items from the waste stream is controlled scavenging at the landfills. Some countries ban scavenging from Controlled Landfills and entirely from landfills. However, such schemes can be successful even in developed countries such as the "*Revolve*" scheme in Canberra. In this type of scheme, a community group has a designated area of land set aside at the landfill for the receipt and sale of reusable items. Other cities establish "dump shops" at or near the landfill to sell recovered items. These schemes can be operated in a safe and sensible manner to avoid health risks and manage safety issues.

The alternative of a mechanised Materials Recovery Facility is really only appropriate with segregated or select waste. Waste segregation options and the locally adopted approach are discussed elsewhere.

The most common approach is to allow scavenging but introduce some rules such as no children allowed and provide some training on the health risks involved, etc.

For several years now, Payatas Dumpsite has become the lone disposal facility of Quezon City and haven for scavengers. The number of scavengers in the disposal site has increased tremendously when Smokey Mountain, a dumpsite located in the western part of Manila was closed and the scavengers in this dumpsite migrated and sought refuge at the Payatas disposal facility. This is so because waste picking is their only known trade and source of livelihood. And like Smokey Mountain, Payatas is situated in metro Manila, hence, very accessible to them.

At present, there are more than 2,000 scavengers, fourteen scavenger associations in the said facility, including women and children whose source of livelihood comes from picking and selling recyclable materials out of the waste dumped. Each scavenger group is allowed 20 – 30 minutes to pick on the dumped wastes for recyclables and other materials with value for them. The associations of scavengers were organized to prevent competition and rivalry among them. Each association is given respective area/s and schedules of waste picking activities. Scavengers who are not members of these authorized associations are not allowed to scavenge at the disposal facility.

To improve the living conditions of the Scavengers at the Disposal site in consonance with the Payatas Dumpsite Development Plan, the City undertook the following programs/projects:

- To organize the scavengers into one association as a cooperative and be registered with the proper authority.
- To hire at least one member of each family of scavengers as worker at the MRF within the disposal facility.
- Low-cost housing projects for the scavengers.

- Granting of soft loans for scavengers to engage in junkshop trading and other similar business activities.

6.5. Pricing

A major influence on the success of waste minimisation and, indeed, recycling is the pricing regime for waste disposal. In addition, charging the full cost of disposal will provide a commercial incentive for business and industry to become involved with waste minimisation and recycling.

In setting the appropriate waste disposal charges the following factors need to be considered;

- operational costs
- present and future costs of purchasing and developing disposal sites
- costs of new equipment in the future
- rehabilitation and long term site monitoring and after-care
- possible costs associated with environmental disadvantages, and
- charges set by external waste management or environmental authorities.

Worldwide experience has shown that merely providing recycling services is not sufficient to reduce waste volumes significantly. Only where there is a direct link with increased pricing of waste services do improvements in recycling rates occur.

Incentive schemes include:

- Garbage by Volume - householders are provided with a specific size waste bin, for a prescribed annual payment; the larger the bin, the higher the annual fee. In Seattle, the charges were gradually increased resulting in a dramatic drop in the number of large bins being used. However, the scheme does not encourage reductions in waste that is difficult to compact, due to the waste frequently being denser.
- Garbage by Weight - each householder's bin is identified by a bar-coding, or similar device and weighed before being collected. Householders are charged on a weight basis for the actual waste disposed of. Separated recyclable materials are not subject to this charge. This scheme promotes illegal dumping and favours the disposal of plastics and packaging which, whilst bulky, weigh relatively little.

6.5.1. "Pay as You Throw" Charging Policy

This is a method of introducing a financial incentive to dispose of less waste, by having the City charging the householder/business on the basis of the amount of waste actually given over for collection and disposal. This internalises the cost of waste services, and provides a strong incentive for generators to minimise waste production. This may be in the form of waste avoidance or greater focus on reuse and recycling, such as composting for domestic situations.

In developing countries, the legislation and ordinances are usually in place but the community culture and enforcement is such that increased littering and waste dumping will usually occur. This has the result of diverting waste away from the collection service and associated correct disposal systems, to encouraging illegal dumping in vacant lots, watercourses and drains.

A further issue noticed even in developed countries is that waste generators will place their waste in other people's bins or receptacles, and not their own. This transfers the waste cost to innocent parties, and can have the effect of introducing neighbourhood tensions.

For less fortunate communities, the City can issue vouchers to partially cover waste costs. This avoids inequalities in service between wealthy and less fortunate Neighbourhoods.

An example of the implications of PAYT charging is a private Landfill in Luzon, Philippines. During the feasibility studies and subsequent design of the site, a daily waste load of 2000 tons was predicted from the local waste generators. Upon opening the site to receive this waste, the waste load quickly dropped to 1000 tons per day. This was a result of waste generators having developed recycling and waste avoidance/minimisation schemes. The quantity going to the Landfill then dropped to around only 100 tons per day, as most waste was illegally disposed of in other locations or controlled dumps with much lower cost gate fees. The locaters are legally obliged to use the private Landfill and tonnages have increased subsequently.

Therefore until the penalty provisions are firmly and consistently applied in the region, and a culture of responsibility for waste generated is engendered in the domestic and commercial community, then a “Pay As You Throw” system may be inappropriate. Rather it is preferable to provide a good collection service that discourages illegal dumping and back yard burning. The other options such as waste management education and better packaging are a better approach for this project.

6.6. Household Hazardous Waste Management

The management of household hazardous waste (HHW) is one area of waste minimisation that can significantly reduce both water system and landfill pollution.

The proper management of HHW is an issue that emerged in the 1980's in the US along with the awareness of problems caused by toxic chemicals and hazardous waste. Collection of HHW at single-day events has been the standard approach adopted by local government.

In many places, collection days have become institutionalised as annual or semi-annual events. In other places, permanent drop-off sites have been established for the ongoing collection of HHW. Established recycling markets for a number of hazardous materials allow materials to be diverted from the waste stream through special collection programs. Used motor oil, one of the largest single categories of hazardous waste generated from homes, is currently collected throughout several cities and states. Scrap battery collections attracted interest in order to reduce heavy metals in landfill leachate and incinerator emissions. Household batteries are targeted for collection in many areas of the US.

In addition to the regular collections, the City should provide facilities at each waste facility for the drop-off of HHW to reduce the impact of these wastes on leachate quality. This should comprise a securable impervious area with separate areas for the storage of oil, batteries, chemicals and paints. The imposition of a fee on these items is not considered appropriate as it discourages people from "doing the right thing" with these wastes.

The disadvantages of the HHW collection days are:

- Management of the individual containers on the collection vehicle. Due to the unknown nature of the wastes a common disposal tank on the vehicle is not practicable and potentially dangerous.
- Kerbside collection is not practical. Personal contact with the householder would be required to collect the HHW.

The advantages of an annual collection of HHW include:

- Remove HHW from the municipal landfills and sewage treatment plants.
- Clear households of these dangerous wastes, particularly where children are present.

6.7. Special Wastes

Special wastes require separate consideration due to the deleterious effects on landfill capacity and leachate quality and are described in Adopted Approach to Waste Minimisation

Both represent a major litter issue and following protracted storm events, are washed out of the local unofficial dumping areas and litter areas through the local drainage canals and into local rivers.

Also they degrade very slowly meaning that these materials are present in the environment for decades impacting both aesthetics as litter and the environment.

Finally plastics are often associated with stormwater drain blockages possibly leading to flooding in municipal precincts.

Therefore management of plastic remains a high priority.

6.8. Adopted Approach

6.8.1. Plastics and Special Waste

QC has outlawed plastic bags with handles. Only square bags for wrapping wet market produce are allowed and paper bags/cartons or reusable fabric bags are used to carry purchases.

Currently there are no controls over PETE beverage bottles which may require additional focus and interventions in the future. These are recycled at the landfill and at HH level at present, but not reduced in terms of initial quantities entering in the waste system cradle to grave system.

eWaste is collected from designated receival areas at malls once a month.

6.8.2. Source Reduction Programs

QC is implementing a number of programs as follows:

- Sinop Basura sa Barangay is a Community-Based SWM Program aimed at reducing the volume of solid waste from source by segregation of waste and the implementation of separate collection or the “No Segregation, No Collection” scheme.
- Junkshop Standardization Program is aimed at incorporating the operation of junkshops to the City’s SWM Program. It is important to note the role these junkshops play in the over-all waste diversion of the City. EPWMD is also currently organizing the operations of these junkshops to provide them with technical training and directions.
- Ecological Solid Waste Management Program at Quezon City Hall is an effort to promote the City’s Solid Waste Management Program and consequently, demonstrate moral ascendancy to its constituents, regular recyclables collection event is being conducted. All Departments, Offices and Units within the QC Hall Complex are directed to observe proper waste segregation and resource recovery in their respective working areas.

6.8.3. Complementary Programs on SWM

In addition, QC has a number of programs complementary to direct SWM activities as follows:

- Door-to-Door Collection System. The door-to-door collection system is specifically implemented in areas that are not accessible to big collection trucks due to its narrow streets, low electrical wirings, no right of way, to name a few. The system makes use of push carts to collect wastes and then transferred to the dump trucks stationed along accessible areas.
    - Of the identified 268 inaccessible areas located at 54 barangays, 162 inaccessible areas in 33 barangays have already this type of system in operation.
- Deployment of Street Sweepers. The presence of waste along the roads despite the regular collection of garbage is one of the problems encountered by the City. To address this, Hauling Contractors were required to deploy fifty (50) street sweepers per district/sub-district at no expense on the part of the City Government. These street sweepers are stationed in the 41 main roads of the City and are tasked to maintain the cleanliness of the streets by daily sweeping, grass cutting, gutter painting, among others.
- Riverways Management. Recognizing the need to also address the deteriorating conditions of the City's waterways as a result of indiscriminate throwing of solid wastes, a Waterways Clean-Up Program was implemented that is spearheaded by the Riverways Sanitation Services (RSS). This group performs regular cleaning and clearing operations in all the waterways surrounding the City. An annual implementation of the Sagip Batis sa QC Program is also being implemented to complement the daily operations of the RSS.
- Legislation and Strict Enforcement of Environmental Laws and Ordinances. To ensure that the SWM program is widely implemented and followed, several laws and ordinances were passed and enforced by the City. A total of 32 Environment Police have been deputized and employed to take on the responsibility of apprehending violators of these ordinances.

6.8.4. Household Hazardous Waste

At present, Quezon City has a collection system for HHW focusing on batteries and fluorescent tubes.

The Scope of Work under this Project requires the following minimum activities to be undertaken to pursue this aim:

- Busted Fluorescent Lamp (BFL) and Spent Household Battery Storage entails the provision of bins that are specially designed for the purpose of temporarily storing the BFLs and spent household batteries that are brought by the residents to the Barangay Materials Recovery Facility (MRF) which shall serve as designated temporary deposit stations.
- Busted Fluorescent Lamp (BFL) and Spent Household Battery Collection entails the collection and proper transport of BFLs and spent household batteries from designated temporary deposit stations to the Service Provider's treatment facility duly accredited by the Department of Environment and Natural Resources (DENR).
- Busted Fluorescent Lamp (BFL) and Spent Household Battery Treatment involves the treatment and stabilization of toxic and hazardous substances

contained in BFLs and spent household batteries before their final disposal to any disposal site duly accredited by the DENR.

- Busted Fluorescent Lamp (BFL) and Spent Household Battery Disposal entails direct and proper transport of treated BFLs and spent household batteries from the treatment facility to the final disposal site.

Table 6-1 Estimated project cost

Fixed Cost (Php)	Variable Cost				Total Project Cost (Php)
	Estimated Quantity	Cost per Kilogram (Php)	Total Cost per Type (Php)	Total Variable Cost (Php)	
1,463,879.20	• 44,500 klgs. – Assorted Busted Fluorescent Lamps (BFL) • 3,400 kgs. – Assorted Spent Household Batteries	• 71.23 / kg. of BFL • 107.52 / kg. of spent household batteries	• 3,169,735.00 • 365,568.00	3,535,303.00	4,999,182.20 or 5,000,000.00

To carry out the project, the Quezon City Government secured the necessary documents and permits from the Department of Environment and Natural Resources through its Environmental Management Bureau-National Capital Region (DENR EMB-NCR) for selected **Barangay Materials Recovery Facilities**, thus allowing the storage of busted fluorescent lamps (BFL) and spent household batteries. To date, only Quezon City's MRFs hold a Certificate of Non-Coverage (CNC) from DENR in the whole National Capital Region.

Also, **EPWMD Pollution Control Officers** have been trained and accredited by DENR to monitor the activities of the Barangay MRFs. Barangay Officials also underwent orientation on the proper handling of busted fluorescent lamps (BFL) and spent household batteries.

From June to November 2015, a total of **15,435 kilograms of BFLs and 30 kilograms of spent household batteries** were collected through this project.

6.8.5. Processing Facilities

Materials Recovery Facilities (MRFs) have been established in several barangays like Barangays Holy Spirit, Phil-am, Bagumbuhay, Vasra, etc. for the processing of collected wastes. A central trading area has also been established in the Payatas Controlled Disposal Facility where the scavengers bring the recyclable materials they have collected.

6.8.6. Bulky Wastes

Collection schedule for bulky wastes is slated every last Sunday of the month following Executive Order No. 24, which declares every last Sunday of the month as Simot Basura sa Barangay Day. This system was introduced to get rid of bulky wastes like dilapidated and old furniture and appliances, tree cuttings and trimmings, getting mixed into the regular household wastes. This also intends to teach the households to segregate their wastes properly.

For almost three (3) years, this project has been implemented at no added cost to the City's constituents and the barangay. However, under the New Quezon City Revenue Code or City Ordinance No. SP-1452, S-2004, which was passed by the City Council and approved by the City Mayor on January 24, 2005, fees for the collection of bulky wastes had to be imposed. The collection of tree cuttings and other yard wastes, on the other hand, remained the responsibility of the City and is still collected every last Sunday of the month as per request of the barangay.

6.8.7. Information, Education and Communication Campaign (IEC)

To raise the level of awareness of the public on the various environmental laws and policies implemented by the City, a massive IEC program is being implemented to achieve the widest participation and support in implementing as well as advocating projects/programs on environmental protection, more specifically on solid waste management. The following were employed to achieve this purpose:

- Showing of cinema infomercials about Quezon City's Solid Waste Management Program entitled Clean, Clean QC.
- Showing of advertisements and infomercials on environmental protection particularly on Reuse, Recycling and Composting in all 82 movie houses in Quezon City (VCD copy).
- Distribution of instructional materials to 142 barangays, 97 public elementary schools, 297 private elementary schools, 45 public high schools, 177 private high schools and 49 Health Centres within the City.
- Hosting of "Earth Day Jam", a musical tribute to Mother Earth, attended by well-known environmentalists, musical artists, and people from Quezon City and nearby cities.
- Conduct of comprehensive IEC Campaign in barangays with SWM Programs as part of the implementation of separate collection or the "No Segregation, No Collection" scheme.
- Distribution of the Honorable Mayor's open letter to business establishments in the City regarding maintenance of cleanliness in their premises.
- Deployment of Solid Waste and Environment Education Program Coordinators (SWEEP Coordinators) as lecturers and campaigners in the implementation of waste segregation and other environmental programs.
- Deployment of IEC Campaigners provided by the City Garbage Contractors on the door-to-door collection system in inaccessible areas and other concerns about the garbage collection system of the City.

In the course of implementing these projects, the following were observed as the resulting impact of the massive IEC campaign:

- Increased public awareness on environmental laws, ordinances and other policies as manifested by several requests for deputation as Environment Police from private citizens and several barangays expressed their willingness to be stewards of the environment.
- Increased awareness on the benefits of proper solid waste management, particularly waste segregation at source, as manifested by the increased number of requests from schools and establishments for the conduct of seminars on proper SWM.
- Awareness on the benefits of proper solid waste management resulted to the reduction of 11.45% waste volume intake at the Payatas CDF or approximately 23,422 cubic meters per month reduction from January to May in previous years.

- Increased requests for EPWMD to provide technical assistance and guidance on SWM implementation.
- Compliance to the No Segregation, No Collection scheme implementation increased as manifested in the reduction of truck requirement per area and consequently, an increase in the solid waste diversion in every barangay.
- Solid Waste Management Programs were also implemented by schools as a result of the continuous IEC campaign. Tapping the future leaders of the country would ensure continuity of efforts towards waste reduction. Also, through the different strategies employed, it was able to instil stewardship, accountability and to a certain extent, values change among the youth.
- Most importantly, cleaner surroundings and well-managed garbage from the households was observed.

7. Approach to Recycling

7.1. Introduction

Recycling is a form of resource recovery that allows the use of recovered materials in a form similar to its original use, as in recycling paper for use again as paper or cardboard. The Solid Waste Management Plan will advocate such practices as it diverts a considerable amount of useful materials present in the waste stream from being disposed of in landfills.

Recycling issues are also addressed in other sections in this Plan, such as Container Deposit Legislation in Source Reduction Options and generally the section on Legal Environment for Source Reduction, and are not repeated in this Section.

- Responsibilities of the Barangay - The Barangay with established MRF shall be responsible for the collection of segregated. Processing of waste shall be done in the MRF prior to the collection of the City contracted waste haulers. The Barangay shall set the guidelines in the storage and collection of waste. As such, the Barangay shall prepare its own SWM plan in accordance with the plans set by the City.
- Responsibilities of the City - The City will be responsible for the efficient collection of waste and shall provide regular collection schedule. For barangays with established MRF, the City shall only collect the residual and bulky wastes (tree cuttings/yard waste) as provided under Section 10 of RA 9003. To encourage the barangay to perform well in SWM, the City grants incentives to barangays with best solid waste management practices and to those barangays utilizing their own garbage trucks for the collection of garbage in their respective area.

7.2. Existing Recycling Programs

Solid waste volume reduction through composting, recycling and other modes of waste recovery is the key in order to reduce the quantity of waste being collected and disposed at the Payatas CDF. The Waste Analysis and Characterization Study (WACS) conducted by the Environmental Protection and Waste Management Department from April to May 2003 revealed that about 6,157 m^3 per day (1,292 TPD) of waste are disposed at the Payatas CDF. The bulk of this waste, which is about 3,631 m^3 per day (762.51 TPD) or 59% of the total quantity, comes from the residential areas. This being the case, the main strategy of this plan will focus on the residential areas/household levels.

Basically, the QC strategy involves the constitution and activation of the Barangay Solid Waste Management Committees that will take charge of the solid waste management of their respective barangay in coordination with EPWMD. This is in compliance with Section 6, Rule VI of the Implementing Rules and Regulations of RA 9003.

The following are the different waste reduction/recycling initiatives implemented by the Department to date:

Quezon City Hall Waste Segregation Program - proper solid waste management policies within the City Hall's Compound with priority on waste segregation at source for moral ascendency. To support this, Solid Waste Management Orientations are annually conducted to constantly remind QC Hall Employees and help them retain the City's segregation policy to increase compliance.

Quezon City Materials Recovery Facility (MRF) – inaugurated last April 24, 2015 as part of the Earth Day 2015 Celebration, the Quezon City Materials Recovery Facility was able to recover a total of 57,063.3 kg of solid waste.

The facility has its separate partitions for the different types of wastes. As one of the pioneering cities in solid waste management, the City Government leads by example through this project which aims to raise the public awareness on proper waste disposal as well as encourages recycling by providing an easily accessible place to divert wastes. With the hope that proper waste management and recycling in the workplace can be a catalyst to its application at home. To date, only Quezon City Hall has its own Materials Recovery Facility among the Metro Manila LGUs.

For biodegradables, kitchen wastes are still collected by the city's accredited kitchen wastes collector while compostable materials are composted through the Takakura Composting method. Monthly recyclable trading is also regularly conducted by the EPWMD and the General Services Department.

Solid Waste Management Summit for the Barangay and Homeowners Association (HOA) Officers - an annual summit/orientation to capacitate Barangay Officials on proper solid waste management and to hear their comments/suggestions on the current status of the implementation of the waste segregation at source and come up with strategies to further improve the program.

In 2015, the EPWMD opted to focus on HOA Officers to recognize their importance to the community and their partnership/cooperation in implementing the City's solid waste management program. The response of the HOA Officers was overwhelming and the EPWMD was able to further encourage QC residents to practice waste segregation at source.

Barangay Recyclables Trading – recyclables trading activity per District together with the barangays and partner recyclers. The project complements the City's campaign on proper solid waste management that aims to encourage the participation of the Punong Barangays and residents in the recovery of recyclables. In this activity, the barangays were able to demonstrate their full support to the waste segregation program of the City by committing and bringing collected recyclables from their respective barangays to the event. In its implementation last June 2015, a total of 19,275 kilograms of recyclables, amounting to Php104, 046, were traded.

Recyclables Trading Project at QC Malls - a monthly recyclables trading activity is also being conducted in Quezon City Malls wherein both traditional (e.g. paper, plastics, metals and bottles) and non–traditional recyclable materials (e.g. electronic wastes, ink cartridges, etc) are bought by recyclers. The project aims to provide a more convenient venue for recyclables trading to enjoin mall tenants and nearby communities in the recovery of recyclables. The trading is conducted in SM Malls (every 1st Friday and Saturday) and Ever Gotesco Commonwealth (every 4th Friday and Saturday).

Participants to this activity are mall tenants and walk-in residents from nearby communities who are committed to make this project sustainable.

In 2015, a total of 90,040.19 kilograms of recyclables, amounting to Php 531,208.20, were traded through this activity.

Plastic Bag Reduction Ordinance - recognizing the importance of enjoining all stakeholders in the city-wide reduction of solid wastes, the City Government enacted City Ordinance No. SP-2140, S-2012 or the Plastic Bag Reduction Ordinance. The ordinance aims to recover used plastic bags from the waste stream and encourage the use of reusable/ recyclable bags as an alternative to single-use plastic bags. A Plastic Recovery Fee (PRSF) of PHP2.00 per plastic bag earmarked a Green Fund that will be maintained by the relevant retailers to be used for environmental projects that will benefit the constituents of Quezon City.

The EPWMD monitors the Green Fund through the submission of Quarterly Monitoring Reports (QMRs) of relevant retailers. To date, the total Green Fund earmarked by Type 1 Relevant Retailers amounts to Php 91,971,459. These funds can only be used to implement environmental projects that benefit the community. In addition, a total of 3,622,435 pieces of plastic bags have been recovered since the implementation of the project during the third quarter of 2012.

Crossings Department Store Corporation and Robinsons Supermarket Store Corporation already expressed their intentions in funding the proposed project of Barangay South Triangle's Solar Rooftop Facility and the Mixed Soft Plastic Waste Recycling and Conversion into School Chairs for Selected Public Schools, respectively, using their Green Fund. Initial meetings were already conducted with the respective proponents and establishments in order to lay down the foundation and initial steps for the implementation of the projects.

Food scrap collection. A limited campaign is being expanded to facilitate collection of source-segregated food scraps with a view to possibly developing centralised composting facilities.

7.2.1. Overall Impact

With all these initiatives, the City was able to attain a waste diversion rate of 56% from January to December 2015. This is equivalent to 2,737,646 cu.m. of solid wastes diverted or approximately 171,103 ten-wheeler dump trucks on full capacity. This percentage is based on estimated total waste generation rates and may require some confirmatory investigations to confirm the precise percentage but the key issue is the QC is actively pursuing waste minimisation and recycling at multiple levels and has demonstrate ongoing commitment to increase the recycling success rate through ongoing innovative programs and trials. Therefore the exact percentage being diverted and recycled is secondary to the demonstrated commitment to maximising the recycling percentage achieved in the future.

All these, together with strengthened enforcement of environmental laws and ordinances, contribute to the high compliance of the City's Barangays to Republic Act 9003.

To further encourage participation of multi-stakeholders, the City Government in partnership with the City Contracted Garbage Hauler Contractors conducts regular Information, Education and Communication (IEC) Campaigns through coordination meetings, orientations, tarpaulin postings and flier distributions.

7.2.2. Junk Shops and Pricing

There are over 2,500 junk shops registered in the City and a further 30% of informal junk shops are believed to exist.

The shops obtains its waste from various sources such as contracted eco-aides that use pushcarts to go through the hard to access sections of the City to collect recyclables. The shop owner usually does not direct the eco-aides on where to collect recyclables, but allows them to source products independently.

In parallel, eco-aides funded by the Barangay collect recyclables door to door. These are then either taken to the barangay MRF (where one exists) or the MRS where local junk shops are used for materials sale.

Individuals and collectives also bring materials directly to the junkshop for sale. This more structured approach to sourcing the recyclables would no doubt increase the quantity of recyclables obtained.

The city has prepared Junkshop Standardisation Ordinance requiring junk shops to obtain all the appropriate permits etc with the aim of standardising all junk shop activities to facilitate ease of recycling and therefore maximise the recycling mass overall.

Table 7-1 International Recycling Material Prices

Material	Form provided	$/Tonne	Remarks
PET Bottles	Clear flake	254- 308	600 mL = 78,000/ tonne
HDPE postconsumer	Natural flake	258-276	
HDPE industrial		199-221	
PVC clear industrial	flake	186-213	
Aluminium Cans	Baled (crushed)	850- 1200	35,000 / tonne
Steel White Goods		60	
Steel – cars	flattened bodies	140 - 217	High rate green strip body
Steel	Sections, plate	340	
Lead	Drained battery	300- 800	
Lead	solid	2600	
Glass	Clear bottle cullet	200 typical	

7.2.3. NGO's

NGOs are represented on the SWM Committees and Boards.

Also, there are a number of active NGOs in solid waste management such as Mother Earth who has developed many MRFs in the Philippines.

7.3. Issues Limiting Recycling

Discussions with various scavengers/junk shops/recyclers have determined a variety of issues limiting recycling volumes and provided some ideas on how to improve recycling efficiency:

- Lack of junk shop storage space preventing some shops recycling plastics and paper/cardboard
- Transport costs as shop is too far from ultimate markets

- Small market size for some components
- Lack of material as comingled waste is still common
- Need compaction/shredding to make it economic to recycle plastic
- Community disinterest
- Community lack of knowledge on what is worth recycling so an expanded education program is essential

7.3.1. Categories of Recyclable Wastes for Diversion

The results from the conduct of ongoing waste characterisation activities to validate waste generation estimates will be the main information input to determine other categories of recyclable waste present in the waste streams for diversion.

7.3.2. New and Expanded Recycling Facilities

To encourage the participation of the general public in the recycling activities and to stimulate the market for these recyclables materials, facilities will be set-up in strategic locations all over the City, following the IEC recommendations and programs. Likewise, mechanisms that will facilitate the coordination with manufacturers and recyclers to collaborate in the implementation of such programs will be put in place.

The City will seek the assistance of various resource groups to implement proactive recycling measures such as buy-back and material reclamation programs.

Products with toxic components must be appropriately dealt with. Reclamation programs for these products will be organised in close coordination with its manufacturers and recyclers who can deal with them. This will supplement the existing HHW campaign.

7.3.3. Building Ordinances

The City has developed a Green Building Ordinance SP-1917 in 2009 that allows EPWMD to apply appropriate rules and regulations, including aspects such as low carbon and low waste building materials are to be used.

There could also be new legislation to require newly-constructed buildings and buildings undergoing specific alterations to contain storage space, devices or mechanisms that facilitate source separation and storage of designated recyclable materials to enable the City to efficiently collect, process, market and sell the designated materials.

Such recommendation will include, but will not be limited to separate chutes to facilitate source separation in multi-family dwellings, storage areas that conform to fire and safety code regulations, and specialised storage containers.

7.3.4. Demand for Products Containing Recovered Materials

The City welcomes proposals that will stimulate the demand for production of products containing post-consumer and recovered materials for as long it meets the acceptable quality standards and consistent with the set guidelines. Members of the City coming from the recycling, manufacturing/packaging sectors and NGO should spearhead the development such proposals.

7.4. Specific Waste Types

The international recycling trends in glass cullet, paper, cardboard and some metals such as iron are highly varied. Some components have been over-subscribed, such as paper and cardboard and the market value once reduced from $200/ton to $20/ton internationally but has now recovered. In 2015, the cost of virgin PET pellets was lower than the cost of recycled pellets because of low oil process. Others remain perennially attractive such as aluminium and copper.

Organics (Food waste and green waste) and plastics represent major waste components and these are addressed in separate chapters following.

Not all materials have to be sold to be recycled. For example, builder's rubble can be used for drainage blankets or gas collection layers in landfills rather than just dumped into the cell as waste, or using excess soil for cover material. This type of recycling just requires some forward planning. Similarly, greenwaste can be chipped and then as a protective layer for the exposed cover material prior to grass establishment to prevent erosion of landfill batters, or used on internal roads during wet weather.

Basic charging policies, container deposit legislation and extended producer responsibility are not considered suitable and effective approaches for maximising the recovery and recycling of PET bottles.

7.5. Adopted Approach

7.5.1. Overview

The City will continue to strongly support the concept of recycling. Based on this, the City will;

- Commit to the principles of encouraging and supporting recycling efforts. The improvement will come through activities such as;
    - Implementing waste segregation sin more Barangays and other facilities such as major shopping malls and institutions
    - City investigations of recyclables' markets, including regional junk shop operators and recyclables processors
    - City identifying specific people from the City to assist with recycling from the SWM Committee and Board
- Accept that the private sector and particularly the market will decide what items and how much is to be recycled
- Accept that the most efficient schemes are those operated by the private sector such as existing junk shops.
- If the volume of goods being recycled again increases substantially, the City will develop some livelihood programs for City residents
- Investigate the use of non-saleable recyclables as raw materials for making a range of handicrafts, such as implemented in Pasig City
- Scavengers at the Landfill will continue to be licenced by the City to avoid any disagreements over who can undertake the recyclables recovery activity and subsequent sale.
- Continue to develop ordinances and legislation to support recycling and waste minimisation, as well as support ongoing recycling education and information campaigns.

7.5.2. Recycling Program

Recycling Programs (see Error! Reference source not found.) are required to address the generation of both biodegradable and non-biodegradable wastes. Specifically for biodegradable wastes, the City will mobilise programs since these wastes can be converted into compost – a useful product that the agricultural activities within and outside the City can benefit from or use as animal feed at householder level:

Table 7-2 Proposed Recycling Focus

Areas to address	Recycling Program
Bio-degradable wastes	Facilitate more segregated collection services to obtain the domestic and commercial and possibly some agricultural waste for conversion into compost soil conditioner/organic fertiliser for use in the area. Encourage further source segregation so food scraps are used for animal feed at the household level
Non-biodegradable wastes: post-consumption	Manufacturers to set-up 'Buy-back/redemption centres' for these wastes
	Promote the use of post-consumer recyclable materials in production (material cycling)
	Educate the junk shop operators to better coordinate their eco-aides to improve collection efficiencies at the household level
	Focus recycling on products presently not recycled in large quantities.
	Processing of materials into products that can be reintroduced into the market (i.e. tin cans can be re-sized into smaller units for consumer use, polystyrene can be moulded to produce new products like mouldings and frames)
	For materials that the City does not have any technology for recycling, the City will coordinate with agencies and academic institutions dealing with R&D on this area. One possible item is Construction and Demolition waste which could be crushed and used as aggregate in non-structural concrete or asphalt, and reinforcing steel recovered for normal metals recycling.

The results of waste characterisation activities and waste composition analysis described earlier in this document and any further information obtained in the course of past collection of solid waste by the City can define the type of waste streams available for recycling. Recommendations with respect to increasing the number of materials designated for recycling will be generated and will form part of the actions necessary in order to operate the ISWM Plan.

7.5.3. Implementation Schedule

Guided by the simple goal setting specified below in **Table 7-3**, the City will develop a municipal-wide implementation schedule that consolidates all recycling initiatives in their area. The City must also ensure that resources are mobilised towards the achievement of these deliverables.

- **Table 7-3 Recycling Implementation Schedule**

Implementation Goals:	
Year 1:	Collection scheme efficiencies operationalized Development of additional ordinances necessary to facilitate the ISWM Plan Implementation
Year 2:	Set-up and full operation of additional Barangay MRFs (Eco-sheds) in urban Neighbourhoods, although the focus will remain at the centralised landfill. Research and Development activities on waste processing Training/Education Program for households and business on reduce, reuse, recycling approach to waste management – some of which is funded by the haulage contractors as required in their contract Incorporation fully of the Ecological Solid Waste Management concepts in the school curriculum
Year 3:	Expansion of existing operations Full implementation of fines and penalties for prohibited acts, non-compliance and violations
Year 4-6:	Enforcement/gradual phase out of the use of avoidable non-biodegradable packaging through legislation Expansion of product lines from waste processing (inputs from R&D activities)

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8. Organics Composting

8.1. Introduction

Composting is often promoted as a suitable scheme for managing organic wastes such as food scraps (15 to 50+% of total waste stream) and green waste (10 to 50% of total waste stream). However it has not been a consistent success in many other developing and even developed countries where it has been adopted, especially where food scraps are introduced into a centralised facility.

Composting trials and facilities were very popular in the 1970s and 1980s. However the failure rate for these facilities approached 100% for a variety of reasons discussed elsewhere. Lately there has been renewed interest in composting however the focus is more on composting chipped green waste rather than the waste food and vegetable scraps.

Composting is the biological process in which organic matter is broken down into simpler compounds by the action of micro-organisms. Compost is the product of decomposition of organic matter. It is a suitable soil conditioner, as differentiated from fertiliser.

8.2. Suitable Materials for Composting

Food wastes that are vegetable or fruit based are fine not compost, as are greenwaste, papers and other carbon sources. Generally meat and dairy products and anything containing oil should be avoided at the household scale

The need to reach a certain C:N ratio of about 30:1 as well as the right moisture content impacts upon what is finally added to the compost system.

In summary for household scale schemes

- YES: fruits and vegetables, such as apples (peels and core), cabbage, carrots, celery, coffee grounds (and filters), eggshells, grapefruit, lettuce, onion peels, orange peels, pears, pineapple, melon rinds, potatoes, pumpkin shells, squash, tea leaves, tomatoes, turnip leaves, etc. Also greenwaste can be added provided that it is not too big. (In composting terms, greenwaste is called “browns” indicating a higher C:N ratio.) Paper can also be added (good source of C) provided that it is not waxed or plasticised in any way.
- NO: dairy and meat products, including butter, bones, cheese, chicken, fish scraps, lard, mayonnaise, meat scraps, milk, sour cream, rice and yogurt. Do not compost foods containing oils or fats such as peanut butter, salad dressing, margarine, and vegetable oil

For commercial or centralised schemes, meat and dairy products can be accepted in small quantities. These schemes have sufficient mass to facilitate higher temperature compost reactions which minimise the odours and general attractiveness of these items to pests.

The collection system must ensure that these types of waste are appropriately segregated and handled during collection to facilitate transfer to the municipal MRF.

The ongoing waste characterisation and generation estimates will be the main input in determining the categories of biodegradable/organic waste present in the waste streams. The data gathering activities will be conducted at the Neighbourhood level, to be consolidated by the designated Municipal ISWM team.

8.3. Greenwaste

Because of the relatively low income status of the communities, and lack of extensive common area parklands and road plantings, there is very little green waste collected at present. Most greenwaste is in fact used as a fuel source at present, and is mainly leaves together with small shrubs and bushes. However as community wealth increases, there will be an increase in green waste for disposal. Other developing countries experience green waste making up at least half of the total organic waste stream.

Once the amount of greenwaste reaches such a percentage locally, a chipper should be purchased to allow the green waste to be broken down into small pieces if larger sized material is being collected. These greenwaste chips can then be composted, perhaps with the addition of animal or treated human waste to provide the correct carbon and nitrogen ratio. Alternatively greenwaste can be used around the landfill site for applying to gravel roads during wet periods and also applying to external batters to limit erosion of the cover material.

The greenwaste is mixed throughout the comingled total waste stream and rarely is collected as a consolidated entity from one location. Because of the small size and non-rigid nature of the greenwaste, it would be very difficult to specifically remove it from the comingled waste mechanically using a screen or trommel.

Separating it out by hand would be exceedingly labour intensive for the benefits gained, based on the waste audit experiences.

At source segregation will also be virtually impossible as the major source is street and compound sweeping where green waste is comingled with dirt and soil.

8.4. Food waste

There are limited options for the reuse or recycling of food waste.

The food waste consisted mainly of fruit and vegetable peelings and trimmings, or spoiled fruit and vegetables.

There was also some rice as well as some meat and cooked food in the samples audited and observed in primary dumping locations as well as waste disposal sites.

The most obvious recycling opportunity given the current financial capacity of the communities is to simply feed the household food waste to animals such as chickens or goats or use home composting. This presupposes that households segregate their food waste so it can be recycled directly at-source by the householder.

Once the community wealth increases and the quantity of food waste increases, then consideration could be given to centrally composting the food waste.

However as the photographs indicate, the food waste is fully mixed throughout the comingled waste and is not in selected pockets, and therefore would have to be segregated at source. This at-source segregation will be required of the following:

Householder will have to segregate prior to either placing the food waste in a dedicated food scraps bin for door to door collection or carrying it to the primary dumping location where separate community bins will have to be provided for food scraps

Commercial premises such as restaurants and hotels will have to segregate waste and then dispose of the food scraps as for the households, depending upon whether there is door to door collection or not.

Market vendors will have to keep food waste separate and place in dedicated food scraps bins.

At all levels, an IEC campaign will be required to ensure that only things that can be composted are placed in the Food Waste bins.

8.5. Composting Scale Options

8.5.1. Domestic Scale

Subsidised or government supported domestic composting schemes are used extensively throughout the world to reduce the amount of organic waste going to disposal. Studies determined that a household composting participation of 15-20% is achievable, realising a 25-30% reduction in domestic garbage quantities in those households. It follows, therefore, that home composting is a valid waste minimisation tool.

Home composting, or at most Neighbourhood level composting, is generally regarded as the most effective level for composting household waste when waste is not source segregated. This allows the organic waste to be used before mixing with contaminating non-compostable materials during haulage and disposal. One exception is market waste that could be composted centrally provided that it is collected in a dedicated service to avoid cross-contamination.

There are several types of manufactured home composting bins available. Municipalities could have schemes whereby bins are made available to the public at discounted rates through either subsidising, passing on savings of bulk purchase to the public or savings associated with sales tax.

Basic low-cost designs are available in the literature, such as in the USEPA "*The Consumers Handbook for Reducing Solid Waste*", 1996. This manual also describes how to operate the compost system and what materials to use.

Alternatively used tyres can be used in a column.

Assuming a 15% reduction in domestic garbage quantities per participating household, and an average of 6 people per household, this indicates that the economic benefits of composting are substantial, when considered in terms of Controlled Landfill and collection services costs.

The home compost approach is the generally preferred option in the long term, for middle class areas or peri-urban areas where the households have sufficient yard areas to use the compost generated.

The basic scheme can involve above an above ground compost system using old tyres placed in a stack, an in ground pit provided the water table is sufficiently low or a specifically designed system made of plastic trays and bins.

8.5.2. Neighbourhood/Barangay

This is probably the most appropriate level for the informal settler areas, where there is insufficient land in each individual household for using the compost. However if lot owners still wish to compost the material it can be used in pot plants or given to other potential users via the Neighbourhood network.

These facilities are located within the residential area and such facilities internationally have in the past resulted in odour complaints even if the facility is roofed.

See **Appendix H – Larger Scale Composting Facility Details** for details on real world experience with neighbourhood and centralised schemes internationally**.**

8.5.3. Large Scale Composting/Mulching

Depending on the type of biodegradable wastes, the following aerobic methods can be used:

- In-vessel composting using motor driven drums or silos.
- Static pile method – using permeable membranes stacked in such a way to allow maximum ventilation, as used at Sun Valley currently.

- Windrow method – 2-3 metre high windrow heaps turned regularly for aeration, utilising compost activators.
- EM Technology – another method of aerobic composting using concentrations of beneficial bacteria to provide high quality compost.

For most schemes, static pile composting would be appropriate.

All composting operations must maintain a maximum temperature of 60 ^oC. Exceeding this level will result to the extermination of the beneficial microorganisms in the composting process. This can be done using thermometers inserted in compost piles. Methods of reducing heat include watering and constant turning of the compost piles until the temperature goes down to the ideal level. Those portions of compost waste with high nitrogen component should be reduced to lower the compost temperature. An ideal carbon-nitrogen ratio must be maintained to avoid over-heating.

Schemes are being trialled internationally for the separate collection of garden waste and the subsequent composting of this material. All green waste is composted in Melbourne Australia at the Deer Park landfill serving over a million people.

Internationally, some Municipalities have proposed schemes whereby the householder can pick up "free of charge" the composted green waste product. However, in doing this, City should be aware of their liability and need to also inform the public of possible weed and plant disease problems. Rehabilitation of former controlled and open dumps, and landscaping of buffers at current operational dumpsites, are other possible uses for the mulch. Mulch has also been used as a substitute for "*end of day*" cover in landfill operations although this is not advised due to the low barrier to rodent and rainwater intrusion.

There are few if any functioning full scale MSW compost schemes operating in developing countries in SE or South Asia. All have failed through a lack of a viable market for the product, poor product quality, lack of funds to continue operation (as they are not self-funding) or ultimately conversion to composting other more suitable material such as animal manure. The one exception is a large scheme handling 1000t/d operates in Lahore, but that is a PPP arrangement where compost contamination is not an issue (as one of the PPP partners is the adjacent farmer using the compost and he does not mind if the compost has foreign objects therein) and finally compost is applied to high value food crops.

Therefore centralised composting must at least await full waste segregation and then undertaking a comprehensive marketing effort to confirm (or otherwise) that market demand is sustainable. Sustainability investigations must include the fact that users are willing to pay a gate price that makes composting economic for the City or that the City is willing to fund the composting scheme with an ongoing financial loss.

One issue to be considered is the risk management required. For example, Municipalities have been sued for damages due to poor compost such as causing crop damage due to excessive microbial activity, or personal injury from sharps accidentally included in the compost product in some countries. Even if the compost is given away, there is an inferred warranty that the material is fit for purpose.

Waste must be fully segregated at source to make this option sustainable as centralised waste segregation of mixed waste is unreliable and costly. This means that centralised schemes are possible only for long term consideration locally, not for immediate introduction.

If there was a larger fraction of greenwaste that could be separated out at source, then that may be viable to compost as it is many other countries, provided that there is a sustainable market and that there is a supplementary source of Nitrogen such as dried sewage sludge (biosolids) from a sewage treatment plant.

To facilitate the processing of biodegradable/organic waste into compost, the following must be put in place:

- **Table 8-1 Actions of waste composting at different levels**

Household Level	• Information Campaign on Household level Waste segregation: (bio and non-bio waste, etc.) • Appropriate containers or bins (Compost bins can be shared among a number of households to maximise resources. Also basic designs using used tyres or in-ground trench system can be developed at low cost) • Distribution of free mulch/compost for use in home composting
Neighbourhood/ Community Level	• "Eco-Sheds" strategically located in urban communes. Common Eco-Sheds can be shared among a cluster of communities, wherever applicable. • This system may not be appropriate now, but may be developed at a later date if required to supplement the household facilities.
Municipal/City Level	• Municipal Composting Centre designed to handle the consolidated volume of pre-segregated wastes to its final conversion to compost • Coordination of compost sales and marketing activities within and outside the City. • Transport system that can facilitate the transport of final product or pre-processed compost to its destination. • Possibly not appropriate at this time given waste is comingled (and is likely to continue to be mixed for some time) and little established market for compost at this time.

In all levels of these activities, the City has the option to consider partner entities or groups to facilitate program implementation and augment resource limitations, as most of these activities might require additional investment.

8.6. Market Development Activities

The organic products that will be derived from the organic processing operations will need to be marketed using a range of schemes. All large volumes of organic products from composting activities should be sold to farmers and agricultural cooperatives. In order the develop the market and demand for compost, the City should consider a partnership or Joint Venture options with regards to developing the potential economic activities that will need a steady supply of compost such as farms for various crops.

Many of the local agricultural soils are poorly structured, and would greatly benefit from applications of compost. The compost will improve soil moisture retention capabilities, increase soil CEC levels to improve fertiliser retention and also a general improvement in soil structure with the addition of compost organics.

However experience elsewhere suggests that few farmers are willing to pay a significant price for compost especially when it used on lower value crops and when supplementary fertilising is still required. In the Philippines, there was a stockpile of over 8000 tonnes of compost which the operators cannot even give away as local farmers are insisting that the landfill operators pay the haulage and distribution costs of the compost throughout the farm.

Storage sites will be required;

- for off-specification product,
- during periods of no sales or wet weather when farms cannot accessed, or
- when there is no market demand due to cropping cycle constraints.

The international trend is to have substantial buffer requirements around compost facilities, because even the best run compost scheme is odorous at some times. Some countries require up to a 5 kilometre buffer from large facilities to residential development, but up to 1 kilometre would be appropriate for a Municipal level scheme.

8.7. Alternative Biodegradation Schemes

Vermiculture is an alternative to composting. Locally there has not been too much success with vermiculture schemes because of worm deaths and the costs involved. Generally the market does not seem willing to pay the additional costs of the vermicast.

There is potential for worm sale (fish food) and castings sale (soil conditioner, like compost). Advantages are less odour risk, no enzyme costs, castings are safe from sharps, pathogens but may still be toxic due to heavy metals or inorganic biocides, etc and disadvantages such as labour intensive, need some technological skills, cannot handle all putrescible wastes, etc.

8.8. Summary

The compostable material must be completely separated from the rest of the waste. This is best done at the source - by the householder or commercial operator. However, this requires considerable co-ordination and encouragement from City's and Neighbourhoods. Separation can be done at the MRF or Landfill, however this adds significantly to the cost and effort required and is never 100% successful with residual contaminants remaining in the compost.

Separation of the waste needs to be thorough as an occasional piece of metal or other solids in the waste stream causes faster wear or even partial destruction of the shredding equipment and lowers the overall quality of the compost, and presents health and safety risk as do glass shards or sharps.

The initial outlay and operating costs of a centralised composting facility would be substantial. Well in excess of USD100k is required to establish a mechanised system that will handle only a few tonnes per day. Technical expertise would be required to operate the facility and market the end product. Basic systems using open weave bags and little mechanisation are more appropriate locally, if the City is interested in centralised composting of just some selected waste stream components.

A sustainable market needs to be found for the compost generated from the material. This often proves difficult as demand is low and there are many other better and cheaper sources of compostable material. Also farmers commonly advise that they are disinterested in having to apply two items to their crops namely compost and supplementary artificial fertilisers. Composted waste is relatively low in nutrients and so farmers need to add additional nutrients in most cases.

It may be better to encourage home level composting by subsidising the cost of composting bins and by providing free advice on the associated benefits and methods. This would help to reduce the overall volume of waste.

Neighbourhood level composting may be appropriate where the community is impoverished and individual households do not have the compound area available to utilise the compost produced. However all compost operations are odorous at some time. Some operations emit odours which are almost continuously detectable at a distance of more than one kilometre from the operation. This odour issue has resulted in many neighbourhood schemes being forced to close.

The other factor is heavy rain. Excess water in the compost pile reduces pile aeration, which reduces efficiency and increases odours. Roofing the operation would be prohibitively expensive, unless a high rate in-vessel system was adopted. In-vessel composting systems require purpose built reactor tanks and are expensive to construct and operate.

Assuming that all the above issues can be overcome, a sustainable market needs to be found for the compost generated from the waste material. This always proves difficult as generally demand is low. The addition of chicken manure, treated sewage sludge or inorganic fertilisers to increase nutrient content may assist in making the compost more marketable. If this later stage is to be undertaken, then a PPP should be established with a local landholder who will commit to taking all compost generated and not suing the City in case of any compost-derived crop or soil contamination, or worker injury from glass or metal shards.

Therefore, at this stage, encouraging householders to undertake composting at home is strongly supported. This will require City and Neighbourhood support in terms of education and/or supply of subsidised compost bins or used tyres.

In the longer term, trials of regional or centralised composting facilities using chipped greenwaste together with sewage sludge or some or other nutrient rich source may be worthwhile.

However the fact remains that a compost scheme, be it a household, Neighbourhood or centralised facility, will not be able to manage all wastes generated, either in terms of volume or waste type. It is a worthy supplemental scheme however, and is discussed in later sections in more detail.

8.9. Adopted Approach

The City is interested in supporting composting schemes, through;

- Primary support for household level composting, but NOT making it compulsory. Support would include the following;
    - Issuance of compost starter kits or leaflets if using shallow burial method to households and also running an IEC advising them how to compost. This will be as part of the overall IEC, and is to be funded by the City and Neighbourhood in partnership.
- Funding of Neighbourhood composting facilities is not supported at this time. The only mid-scale compost facility that will be supported by the City
- The City considers that a centralised facility could not be justified for such a relatively small waste component at this time, unless expensive chipping and milling systems were installed to process the greenwaste for co-composting. However, if the overall waste stream volume increases dramatically, then a centralised composting scheme for residual biodegradables and processed greenwaste will be investigated.
    - This level of composting will only succeed if a stable market for the compost is developed and maintained and a rigorous quality control program is in place.
    - The small number of successful and sustainable centralised composting scheme are PPPs and this is the model that will be considered in future, as appropriate

9. Population Projections and Waste Generation

9.1. Background

Preliminary estimates have been made for both population projections and waste generation rates for 30 years.

The population projections are primarily based on the latest baseline Census figures and adopted growth rates.

9.2. Waste Generation Allowance

Waste generation data in the City is presently limited to projections based on population estimates and density determinations. There is no weighbridge stationed at the landfill entrance, but there is local public weighbridge, but no portable truck scales are available for hire, so accurate aggregated waste haulage tonnage figures are non-existent. Added to that, most cities do not have a high level of accurate quantification of the collection service efficiency to allow the mass of waste being hauled to be accurately related to a service area population in any case. Most local waste generation rates are based solely on mass estimates or very small samples being weighed and then greatly extrapolated. In addition, there is little substantive data on what fraction of recyclables are diverted for door to door sale at household level. In summary, little credence should usually be placed on local per-person waste generation rates.

Projects in other developing countries like Vietnam and the Philippines often use a rate of at least 0.5 kg/p.d going up to 0.95 kg/p.d for provincial cities. However in Thailand for example it can be as high as 1.5kg/p.d. Developed countries can generate up to three times this amount.

These amounts account for at source (in-house or in-institution) recycling and reuse. Higher value recyclables such as glass, metal and paper are already being recycled at source. This is typical of most developing countries where these high value recyclables traditionally account for 3 to 5 per cent of the total waste stream for each component.

QC has undertaken volume measurements of waste entering the site as well as some density determinations, and these have been used to develop waste generation rates. The waste generation allowance was therefore set at 0.88kg/p.d initially increasing to 1.57kg/p.d over 30 years to account for increasing community wealth and therefore, higher per capita waste generation. .

9.3. Collection Allowance

The current percentage of waste collection is estimated to be over 90% in the city core.

The ultimate aim is of course to approach 100% collection efficiency, but this may only achieved in the very long term following cultural changes which accept that littering is not desirable, and supported as well by a campaign of fines associated with littering. However, significant changes in the community attitude towards littering will be generational and not expected to be significant in the life of the controlled landfill proposed.

With the recommended improvements in this report, it may be expected that the collection percentage will increase to 95% in the long term.

9.4. Recycling Allowances

As the wealth of the community increases, the amount of waste generated will increase.

However, this does not translate into a proportional increase in the quantum of waste to be collected and disposed of. The key changes with increasing wealth relates mostly to increased packaging, for such as paper, cardboard, tins and bottles. So as the amount of waste generated per person increases, so does the amount of recyclables, resulting in much smaller growth rate for the waste to be disposed of compared with the total increase in the mass of waste generated.

9.5. Soil Cover Allowance

Three types of soil cover are required to operate a landfill correctly. The first and possibly most critical is the application of daily cover to a thickness of 100 to 150 millimetres. This cover provides a multitude of engineering interventions including a reduction in water infiltration leading to less leachate generated, less vermin on site, reduced bird numbers on site, reduced litter and reduced odours.

If an area of the controlled landfill is to be left unused for a period of a few months or more, intermediate cover to a thickness of 300 mm should be applied.

Final cover usually consists of two layers. The first layer is a 600 millimetre thick clay or silty clay cap to prevent rainfall infiltration. This should be topped with a layer of growing medium of compost or top soil to facilitate plant growth.

The application of cover can contribute some 15 and to 25% of the total landfill volume. However, smaller percentages are possible at well run landfills by recovering the daily soil application prior to commencing another lift of waste.

For this study, it has been assumed that 10% of the total landfill volume will be cover material initially. This is because it is expected that the daily cover may in fact be only applied on a weekly basis or at some other lesser frequency. Over time this will increase to 15% as operations improve.

9.6. Compaction Allowance

There are two options for providing compaction at the controlled landfill. The most common is the use of a tracked bulldozer which at the usual size of a D6 or D7 equivalent. However, for larger landfills, a purpose built landfill compactor can be used:

The typical waste density then achieved at the landfills assuming that the waste arrives relatively uncompacted as it was hauled in a mix of compactor trucks and open trucks:

- no compaction - 300kg/m^3
- 500kg/m^3 minimum with bulldozer or tracked loader
- 650kg/m^3 minimum with smallest specialised landfill compactor (handles 500t/d working with a bulldozer)
- 1,000kg/m^3 minimum with largest specialised landfill compactor (handles 1000t/d working with a bulldozer, so only for very large landfills)

Because of the size of the controlled landfill, a suitable number of dozers, excavators and one compactor are in use to push and shape the waste quantities and provide some compaction prior to applying cover.

The adopted initial density is 650kg/m^3 increasing to 900 kg per cubic metre over time as the operations further improve and larger compaction equipment is used.

9.7. Waste settlement

Waste settles over time and it has been assumed that 5% of the volume will be lost in the first year, in accordance with recorded results from many landfills.

The waste will continue to compact at 0.5% per year on average over the following 30 years.

9.8. Airspace Consumption

Based on the above assumptions, the cumulative waste volume taken up at the controlled landfill has been calculated on an annual basis (see **Table 9-1**).

Based on this theoretical waste volume, the controlled landfill stages have been sized. Traditionally the first stage or cell at a controlled landfill should provide some 5 year's capacity. Typically, the overall controlled landfill site selected should have capacity for at least 20 plus years operation.

In reality there are numerous factors that could eventuate and impact upon the assumptions and predictions for this predicted landfill life in the coming decades. However, these impacts can be counteracting, such as a lower growth rate than that predicted could be contrasted against a higher per person waste generation rate and so on.

Therefore, it is recommended that the following table of cumulative waste volume be adopted as the best available predictions at this time. Any variations to the many components intrinsic to this prediction will only alter the life of the controlled landfill and not the concept nor the basic design approach. If the cumulative waste volume at the controlled landfill is either significantly larger or smaller compared with the predictions below, then the later cell sizes can be amended to compensate for these variations.

These projections will obviously be refined during later stages of this technical assistance as the interventions are refined and agreed, and also at the time of detailed design.

The Payatas site is an evolving facility especially in the Mondragon area where the footprint is being extended regularly as local informal and formal settlers are resettled. Therefore the life of the existing facility is somewhat open ended and will depend on the footprint extensions and waste mass reductions as a result of the mooted WtE facility.

Table 9-1 Population and Waste Load Projections – Detailed

YEAR	Qalat Annual Growth Rate	TOTAL Population	Serviced Area Percentage of Qalat Area	Projected Serviced Population	Rate of Waste Generation (post HH Direct Recycling)	Daily Waste Generated in Serviced Area	Percent Collected in Serviced Area	Percent Recycled Post HH	Daily Waste Delivered to Landfill	Percent Recycled at Landfill	Waste placed into landfill	Landfill Insitu Waste Density	Annual Totals (with no allowance for settlement)			Cumulative Totals					YEAR
	%	Persons	%	Persons	kg/p.d	t/d	%	%	t/d	%	t/d	kg/m^3	t/yr	%	Cubic Metres	t	Cubic Metres	Cubic Metres	Cubic Metres	Cubic Metres	
		Agree base population and percentage growth rates	Often assume percentage increases with future collection equipment upgrades	Persons	Input current rate and increasing over time. Based on recycling at home or at source	Tonnes/ day	Increasing as illegal dumping and self disposal reduce	Includes recycling from primary disposal locations. Usually increases over time. Does not allow for major WtE diversions which are proposed but not confirmed.	Tonnes/ day	Will there be a real change over time? Usually is an increase.	Tonnes/ day	Waste density usually increases over the years as better equipment utilised.	Tonnes/ year	Percentage of Cover (Often initially 10% and increasing to 20% or more as operation improves)	Total Airspace Consumed (with no allowance for settlement)	Tonnes Disposed	Cover material required (m3)	Total Airspace Consumed (with no allowance for settlement)	Settlement and Consolidation	Cubic Metres of Airspace Consumed (Allowing for settlement)	
2016	1.92%	3,008,000	90%	2,708,000	0.88	2383	80%	15%	1620	30%	1134	650	415,000	10%	640,000	415,000	59,000	640,000		640,000	2016
2017	1.92%	3,065,800	90%	2,760,000	0.89	2456	80%	15%	1673	30%	1171	650	428,000	10%	660,000	843,000	60,000	1,300,000	32,000	1,268,000	2017
2018	1.92%	3,124,700	90%	2,813,000	0.90	2532	81%	16%	1726	30%	1208	650	442,000	10%	681,000	1,285,000	62,000	1,981,000	72,000	1,909,000	2018
2019	1.92%	3,184,700	90%	2,867,000	0.92	2632	81%	16%	1797	30%	1258	650	460,000	10%	709,000	1,745,000	65,000	2,690,000	116,000	2,574,000	2019
2020	1.92%	3,245,900	90%	2,922,000	0.94	2736	82%	16%	1870	30%	1309	650	478,000	10%	737,000	2,223,000	67,000	3,427,000	165,000	3,262,000	2020
2021	1.92%	3,308,300	91%	3,011,000	0.96	2876	82%	17%	1968	30%	1378	650	503,000	10%	775,000	2,726,000	71,000	4,202,000	219,000	3,983,000	2021
2022	1.92%	3,371,900	91%	3,069,000	0.97	2990	82%	17%	2048	30%	1434	750	524,000	10%	700,000	3,250,000	64,000	4,902,000	278,000	4,624,000	2022
2023	1.92%	3,436,700	91%	3,128,000	0.99	3108	83%	17%	2131	30%	1492	750	545,000	10%	728,000	3,795,000	67,000	5,630,000	337,000	5,293,000	2023
2024	1.92%	3,502,700	91%	3,188,000	1.01	3231	83%	18%	2217	30%	1552	750	567,000	10%	757,000	4,362,000	69,000	6,387,000	400,000	5,987,000	2024
2025	1.92%	3,570,000	91%	3,249,000	1.03	3359	84%	18%	2307	30%	1615	750	590,000	11%	788,000	4,952,000	79,000	7,175,000	468,000	6,707,000	2025
2026	1.92%	3,638,600	92%	3,348,000	1.05	3530	84%	18%	2426	30%	1698	750	620,000	11%	828,000	5,572,000	83,000	8,003,000	541,000	7,462,000	2026
2027	1.92%	3,708,500	92%	3,412,000	1.08	3670	85%	19%	2523	30%	1766	800	645,000	11%	808,000	6,217,000	81,000	8,811,000	620,000	8,191,000	2027
2028	1.92%	3,779,800	92%	3,478,000	1.10	3816	85%	19%	2624	30%	1837	800	671,000	11%	840,000	6,888,000	84,000	9,651,000	702,000	8,949,000	2028
2029	1.92%	3,852,400	92%	3,545,000	1.12	3967	85%	19%	2729	30%	1910	800	698,000	11%	874,000	7,586,000	87,000	10,525,000	789,000	9,736,000	2029
2030	1.92%	3,926,400	92%	3,613,000	1.14	4124	86%	20%	2838	30%	1986	800	725,000	11%	908,000	8,311,000	90,000	11,433,000	882,000	10,551,000	2030
2031	1.92%	4,001,800	93%	3,722,000	1.16	4333	86%	20%	2982	30%	2087	800	762,000	11%	954,000	9,073,000	95,000	12,387,000	981,000	11,406,000	2031
2032	1.92%	4,078,700	93%	3,794,000	1.19	4505	87%	21%	3100	30%	2170	850	793,000	11%	934,000	9,866,000	93,000	13,321,000	1,086,000	12,235,000	2032
2033	1.92%	4,157,100	93%	3,867,000	1.21	4684	87%	21%	3222	30%	2255	850	824,000	11%	971,000	10,690,000	97,000	14,292,000	1,194,000	13,098,000	2033
2034	1.92%	4,237,000	93%	3,941,000	1.24	4869	88%	21%	3348	30%	2344	850	856,000	12%	1,009,000	11,546,000	109,000	15,301,000	1,309,000	13,992,000	2034
2035	1.92%	4,318,400	93%	4,017,000	1.26	5062	88%	22%	3479	30%	2436	850	889,000	12%	1,048,000	12,435,000	113,000	16,349,000	1,430,000	14,919,000	2035
2036	1.92%	4,401,400	94%	4,138,000	1.29	5319	88%	22%	3654	30%	2558	900	934,000	15%	1,040,000	13,369,000	136,000	17,389,000	1,557,000	15,832,000	2036
2037	1.92%	4,486,000	94%	4,217,000	1.31	5529	89%	23%	3795	30%	2656	900	970,000	15%	1,080,000	14,339,000	141,000	18,469,000	1,689,000	16,780,000	2037
2038	1.92%	4,572,200	94%	4,298,000	1.34	5748	89%	23%	3942	30%	2759	900	1,008,000	15%	1,122,000	15,347,000	147,000	19,591,000	1,827,000	17,764,000	2038
2039	1.92%	4,660,000	94%	4,381,000	1.36	5976	90%	24%	4094	30%	2866	900	1,046,000	15%	1,164,000	16,393,000	152,000	20,755,000	1,972,000	18,783,000	2039
2040	1.92%	4,749,500	94%	4,465,000	1.39	6213	90%	24%	4250	30%	2975	900	1,086,000	15%	1,209,000	17,479,000	158,000	21,964,000	2,125,000	19,839,000	2040
2041	1.92%	4,840,700	95%	4,599,000	1.42	6527	91%	25%	4459	30%	3122	950	1,140,000	20%	1,203,000	18,619,000	201,000	23,167,000	2,285,000	20,882,000	2041
2042	1.92%	4,933,700	95%	4,688,000	1.45	6786	91%	25%	4629	30%	3241	950	1,183,000	20%	1,248,000	19,802,000	208,000	24,415,000	2,450,000	21,965,000	2042
2043	1.92%	5,028,500	95%	4,778,000	1.48	7055	92%	26%	4804	30%	3363	950	1,228,000	20%	1,296,000	21,030,000	216,000	25,711,000	2,623,000	23,088,000	2043
2044	1.92%	5,125,100	95%	4,869,000	1.51	7333	92%	26%	4984	30%	3489	950	1,274,000	20%	1,344,000	22,304,000	224,000	27,055,000	2,804,000	24,251,000	2044
2045	1.92%	5,223,600	95%	4,963,000	1.54	7624	92%	27%	5171	30%	3620	950	1,322,000	20%	1,395,000	23,626,000	233,000	28,450,000	2,993,000	25,457,000	2045
2046	1.92%	5,323,900	95%	5,058,000	1.57	7925	93%	27%	5363	30%	3754	950	1,371,000	20%	1,447,000	24,997,000	242,000	29,897,000	3,191,000	26,706,000	2046

10. Development and Evaluation of Collection Alternatives

10.1. Background

The collection system can impact upon 3R implementation, particularly the recycling aspect, and less so the waste minimisation/reuse issues. These later aspects can be impacted by source segregation requirements if for example a multiple bin collection approach is adopted.

Appendix I – Background to Waste Containers, Segregation and Collection System provides an overview of the options and how they interact, as well as description of the types of equipment available and their relative advantages and disadvantages.

Therefore some consideration of the collection system, and therefore the waste segregation issues and their interactions, is appropriate.

Further, significant recycling happens during waste hauling as the collection staff scavenge through the waste on the way to the dumpsite. Therefore if compactor vehicles are proposed in the future, then waste recovery needs to happen either at source (Household or enterprise), in the primary dumping areas or at the dumpsite, but obviously not during haulage activities.

10.2. Collection System Planning

In terms of haulage capacity, Identifying goals, objectives, and constraints can help guide the planning process. Issues that should be considered include the following:

- **Level of service**: What level of services is required to meet the community's needs? What materials need to be collected and what are the requirements for separate collection of these materials? What needs and expectations exist with respect to the frequency of pickup and the convenience of set-out requirements for residents?
- **Roles for the public and private sectors**: Is there a policy preference regarding the roles of the public and private sectors in providing collection services for wastes and recyclables? If collection is to be performed by private haulers, should the City license, franchise, or contract with haulers?
- **Waste reduction goals**: What are the community's waste reduction goals and what strategies are necessary or helpful in achieving those goals? For example, source reduction and recycling can be facilitated by charging customers according to the volume of wastes discarded, by providing convenient collection of recyclables, and by providing only limited collection of other materials such as yard trimmings and tires.
- **System funding**: What preferences or constraints are attached to available funding mechanisms? Are there limits on the cost of service based on local precedence, tax limits, or the cost of service from alternative sources?
- **Labour contracts**: Are there any conditions in existing contracts that would affect the types of collection equipment or operations that can be considered for use? How significant are such constraints and how difficult would they be to modify?

Communities can select the level of services they wish to provide by choosing how often to collect materials and the point from which materials will be collected at each residence. The greater the level of service, the more costly the collection system will be to operate. Factors to consider when setting collection frequency include the cost, customer expectations, storage limitations, and climate. Internationally, most municipalities offer collection once or at most twice a week in tropical climates. Some wastes such as segregated greenwaste is only collected every two weeks quite often.

Crews collecting once per week can collect more tons of waste per hour, but are able to make fewer stops per hour than their twice-a-week counterparts. A USEPA study found that once-a-week systems collect 25 per cent more waste per collection hour, while serving 33 per cent fewer homes during that period. Some communities with hot, humid climates maintain twice-a-week service because of health and odour concerns.

A number of options exist for each of the first three components. Choice of which option to develop is dependent upon existing practices, new planned activities, and input from ISWM staff and stakeholders. From an inventory of existing municipal assets and equipment, the current waste management practices (primary collection, secondary collection and existing disposal practices), feedback from the stakeholders, and acknowledgement of the limitations of budget, a plan can be formulated that will address the goals established for environmentally sound ISWM.

10.3. Household/commercial production, storage and collection

This primary system is necessary to ensure waste stored at source is collected regularly and not discarded in streets, drains, water bodies, etc. It is important that this step is designed to synchronize with the secondary waste collection step to ensure complete system functionality.

Waste density is highly variable and for non-compacted waste in developing countries (with typical municipal waste characteristics) it can be as low as 150kg/m^3 or as high as 350kg/m^3 if auto-compacted during haulage due to travel vibration as well as walking over by jumper boys during collection and if the waste contains a high proportion of street sweepings (dirt and sand). Based on the density determinations conducted as part of the waste audit, the adopted density is therefore 260kg/m^3.

Commercial premises can vary greatly depending upon their commerce. Their waste containers must be appropriate for their waste production, or they will need multiple containers.

10.4. Primary waste collection process

10.4.1. Background

There are a number of approaches to collection of waste from residences and commercial producers. Together these are illustrated together in **Table 10-1**, and described in detail as follows. Presented here are some of the possibilities.

- Householder separates the organics and fines, composts them at the house, and then places residuals in a small household bin. Door-to-door collection of home bins with manually operated handcart by community worker.
- Door-to-door collection of home bins with manually operated handcart by community worker.
- Door-to-door collection of waste piles by community worker.
- Householder takes waste to community bins as it is produced.
- Householder places waste in indiscriminate piles, to be collected by community worker.

Since 40% of the waste has been measured as food scraps, it means that composting at the household level has the potential to have beneficial impacts on ISWM management from primary collection to final disposal.

Depending upon space available, there may not be enough room to compost on-site. However, a mini enterprise for private company could be developed, that could get paid a small amount to take the waste away, than can sell the final product to farmers.

Diversion of the organic waste also reduces the odour and vector attraction of waste stored at the household and subsequently in primary dumps if a community based system is adopted.

At present, many households and commercial establishments dump their wastes in relatively uncontrolled piles that may or may not be formally designated.

Piles are subject to animal scavenging and scattering of the waste and is the least preferable option. Although virtually no coordination is necessary between the household and the collector is required, uncontainerised waste requires collection crews to hand-collect loose waste from the street, which is a hazardous and time-consuming practice.

One of the key factors that requires a concerted effort and buy-in on the part of the community is proper use of waste drop sites. In many instances, a trash dam is not properly used, so the result is not dissimilar to having an open trash dump site with similar visual, odour and health concerns. This may require an aggressive education effort.

Changing to waste bins (Hook-lift or skip bins) also require some community engagement to ensure that the waste is placed in the bin by the householder or commercial institution, and not just dumped near the bin.

10.4.2. Door to door collection

This the current practice where vehicles can access the individual houses. Where there are access difficulties, then “barrow boys/ eco-aides” collect the waste in pushcarts and bring to primary dumping locations for collection by trucks.

10.4.3. Community bins

A number of both formal and informal drop sites exist for community-level solid waste collection at present. This confirms that a certain level of flow from primary to secondary to final deposit already takes place and is accepted by the community.

With most of the options, the waste is collected through the primary collection system and temporarily stored at community collection drop points – “trash dams,” bins, or skips - prior to being transported in bulk to the waste treatment or disposal site, or possibly a transfer station. The function of this component is solely to provide an interim storage site to make operations more efficient. As such, it is very important that they are:

- capable of holding the entire amount of waste brought to them during a set period (for instance, to be able to hold a week’s worth of contributions from primary collection if that is adopted as the collection frequency),
- emptied prior to new cycle of waste being brought to them – that is they are synchronized with primary collection, and
- easily emptied and accessible for transport vehicles.

There are a number of alternatives for drop points (primary dumping locations), including

- not using formal drop points – just allowing uncontrolled open dumping
- uncontainerised, open piles in agreed locations
- trash dams (permanent concrete or steel bunkers)

- hook-lift bins matched to the collection truck.
- skip bins matched to the collection truck

The open pile alternative is by far the least desirable; the hook-lift bins or skips are the most efficient and clean, but are by far the most expensive initial cost requiring specialized matched equipment. Concrete bins are the midway option.

Hook lift bin systems do not provide any compaction and even partially full hook-lift bins will sometimes need to be transported. Bins cannot be added to one another to fill one bin (to maximise haulage efficiencies) unless waste is manually shovelled from one to the other.

Skip bins are loaded into a compactor truck where not only is the partially full bin issue then overcome, but the compactor truck can then double or treble the waste density making haulage far more efficient.

Locating any of these containers is an important decision. It is important to consider:

- Containers are located strategically, taking into account where community workers or households have established past drop practices.
- There is adequate space to place one or more containers, and access by the collection vehicle.
- They do not obstruct the entrance of any building, or hinder traffic.
- Neighbours will not vandalise them if the waste become odorous or if feral animals spread the waste
- The walking distance from the edge of the bin catchment is sufficiently short so that residents will take waste to the primary dumping location and not fly dump or litter instead. Anything less than 250 metres is usually considered sufficiently close, but reducing this to a 100 metre maximum walk if possible has been found to reduce illegal dumping to very low levels.

The value of locating at existing informal waste disposal sites is that the community is used to these drop locations, and the change in appearance (when a bin, skip or trash dam is placed) is a noticeable visual improvement. Thus objections from the community should be minimal in that case.

Table 10-1 Selected alternatives for community waste collection

	Open piles	Trash dams/Bunkers	Hook-lift Bins	Skip bins
				
Price/unit	- 0 -	US$400 to $600	US$600 to $1500	US$400 to $1200
Vehicle required	Non-specific	Non-specific	Hook-lift truck matched to bin	Forklift-type compactor truck matched to bin
Positives	• Low cost • Disposal points presumably established by community needs	• Static so residents have defined disposal point • Relatively inexpensive • Requires no special equipment • Fabricated locally	• Bins easier to relocate as they are not fixed • In an emergency, small bins can be lifted by crane trucks which are relatively abundant, known by mechanics & operators • Fabricated locally • Easily removed, cleaned, repaired and replaced • Bins replaced immediately by empty bin	• Bins easier to locate as they are not fixed • In an emergency, skip bins can be lifted by crane trucks which are relatively abundant, known by mechanics & operators • Fabricated locally • Easily removed, cleaned, repaired and replaced • Skip bins recycled immediately and waste is compacted in truck
Negatives	• Alternative that most results in waste being irresponsibly discarded on streets. • Requires collection crews to hand collect loose waste from the street, which is a hazardous and time-consuming practice. • Allows animal access to scatter waste • Difficult to locate as residents don't like them beside house	• Difficult and slow to access & awkward to empty • Manual labor required to empty exposing workers to health hazards • Difficult to locate as residents don't like them beside house • Often vandalized and any metal doors stolen	• Requires specific hook-lift truck matched to bin • Lifting and unloading can cause damage to containers. • Very low risk of container being stolen • Does not allow compaction in transit to landfill	• Works best with specific fork truck matched to bin • Lifting and unloading can cause damage to containers. • Low risk of container being stolen • Does allow compaction during transit to landfill

10.5. Adopted Primary Waste Collection System

The easily accessed areas receive door to door collection services provided generally by private contractors, with one Barangay using their own vehicles.

Hard to access areas are serviced by push carts where waste is taken to primary dumping locations for collection by larger trucks.

10.6. Secondary collection

Depending upon the particular system and configuration, the number of trucks or tractor-trailers required can be determined (see **Table 10-2**). This also depends upon how long it takes to load the waste and how far it is to a landfill/disposal site. For instance, shovelling out a concrete trash dam or a scattered pile takes much longer than it takes to pick up a skip or hook-lift bin. But it is also possible that a dump truck can hold more than the amount of waste in two trash dams, whereas it may be that the flatbed associated with a crane can only transport two skips/bins.

If non-compacting systems (tractor-trailer, dump truck or hook-lift bins)….

- In many cases hooklift bins, and to a lesser extent also the compactor trucks, will not be full when hauling to the controlled landfill. It has been assumed that on average the loads are only 80 percent of capacity. This will certainly be the case with the hooklift bins and tip truck
- With increased mechanisation of the fleet, an allowance must be made for both breakdowns and programmed maintenance. It has been assumed that only 85% of the mechanical fleet capacity would be available at any one time

Based on these factors the tonnage capacity required is 1600 tons/day.

- **Table 10-2 Selected alternatives for community waste haulage**

	Tractor/Trailer	Tip Truck	Hook-lift Bin Truck	Skip bin Truck
				
Price/unit	US$25,000	US$90,000	US$120,000	US150,000
Bin required	Non-specific	Non-specific	Hook-lift bin – various sizes	Bin matched to Forklift-type compactor truck – various sizes possible
Positives	• Equipment is relatively cheap with good availability. • Has a good short turning radius, so it is fairly easy to access tight spots, such as within communities. • Still has maintenance issues with hydraulics associated with the trailer lifting ram (and possibly the front bucket system)	• This system is very similar to the first alternative, but uses a truck with potentially much greater haulage capacity than a trailer pulled by tractor. • Dump trucks are moderately priced with good availability and mechanical support. • Is capable of good road speed when going to the landfill. • Can access replacement trucks easily as these vehicles are used for many other haulage purposes	• Truck has large haulage capacity • Fast to load, empty and replace • Can take up to 30 cubic metres in one bin as no real limit on lift capacity • Trucks are moderately priced with good availability and mechanical support. • Is capable of good road speed when going to the landfill. • Can lift many different bin sizes to suit location needs	• This system is a very quick and clean way to collect containerized waste. • Low labour requirements and costs. • Relatively high weekly waste capacity • Compacts waste up to 3 times the density • Good road speed
Negatives	• Fairly labour intensive to fill trailer by hand. • Shovelling waste is a hazardous and time-consuming practice. • A tractor is very slow on the way to the landfill. • Consider using a transfer station to overcome the tractor's slow speed. • No waste compaction	• Fairly labour intensive to clean out trash dams. • Shovelling waste is a hazardous and time-consuming practice. • A large truck has poor turning radius, so may not be able to negotiate some narrow roads, or turns. But can use a variety of truck sizes to suit road widths in the city • Truck has hydraulic systems for tipping requiring maintenance (same as tractor-trailer systems) • No waste compaction	• Requires specific hook-lift bin • A large truck has poor turning radius, so may not be able to negotiate some narrow roads, or turns. • Does not allow compaction in transit to landfill • Cannot be replaced with other truck types such as tip trucks • Truck has hydraulic systems for tipping requiring maintenance (same as tractor-trailer systems)	• The most expensive in terms of capital investment, and not generally available locally. • Requires significant room to turn, and bin must be aligned with truck. Smaller rear lift vehicles are available for narrow street areas • May require advanced training for mechanics.

10.7. Adopted Secondary Waste Collection System

10.7.1. Existing System

The City is implementing a Macro and Micro Cell-Based Collection System, wherein the waste generation of an area or a cell is equivalent to one truckload of garbage or 16 cubic meters of wastes. This system of collection was established for the following purposes:

- To know the required number of vehicles needed to collect the daily waste generation of Quezon City.
- For proper coding of the service area.
- For proper scheduling of waste collection.

The Cell-Based Collection System is also being used as basis for the Package Clean-Up Contract with the waste haulers/contractors. Under this type of Contract, the contractor is given full responsibility to manage, administer and directly carry out collection, cleaning and disposal of solid waste from various sources.

In terms of collection schedule, Quezon City has three (3) service schedules:

- Main Thoroughfares - collection of garbage is done daily from 4:00 AM to 7:00 AM, with mopping-up operations not later than 9:00 A.M. and 2:00 P.M. Mopping or follow-up collections are undertaken to collect late and untimely disposals. The main thoroughfare areas are of mixed sectors, composed mostly of commercial establishments, some industries and residential houses.
  - Stationary collection – route for public markets and hospitals (domestic wastes only). Collection is done on a daily basis. For government-owned institutions, collection of waste depends on waste volume. Collection is done on a daily, twice or thrice weekly basis.
  - Barangay (residential) collection - scheduled twice-a-week: Mondays & Thursdays, Tuesdays and Fridays, and Wednesdays & Saturdays. The Barangay areas are composed mostly of residential houses mixed with some other sectors like commercial and industrial, etc.

Segregated collection of waste is not yet fully implemented in the City although it is being done in some barangays especially those practicing good solid waste management in coordination with the City. Some residential areas are also practicing waste segregation at source in view of the proliferation of junkshops buying recyclable materials.

Some of the barangays deploy their own garbage trucks in collecting household wastes from selected pilot areas within their jurisdiction. Collected wastes are being disposed at the Payatas Controlled Disposal Facility.

10.7.2. Transfer Stations

Quezon City has no existing facility for the transfer of solid waste prior to final disposal given the proximity of the City's disposal area, which is the Payatas Controlled Disposal Facility.

11. Review of Waste Processing and Disposal Options

Even with waste minimisation education and maximised recycling efforts, there will still be a need for a final disposal option. Alternative methods of waste disposal were investigated as below:

- Incineration;
- pit burners;
- baling;
- composting;
- “Zero Waste” fully-integrated approach and
- Waste to energy

The composting and waste to energy options are presented in separate chapters.

11.1. Incineration

Incineration of waste would considerably reduce the volume of waste for landfilling. A large facility would need to be constructed to burn waste material, thus converting carbon and hydrogen compounds to carbon dioxide, water and other residues. In the process of burning this waste it is possible to generate some energy. The proceeds from energy sale would not offset the entire running costs, let alone redemption on the capital investment.

The negative side of incineration is the need to sort the waste stream prior to burning as not all waste material can be burnt. The most significant disadvantage is the generation of exhaust gases (some potentially harmful gases) and the visual intrusion of the chimney stack. Specialist knowledge is required to operate and maintain an incineration facility which adds significantly to the life cycle costs.

Incineration was not considered a viable option due to the disadvantages and high capital and operating costs of such a facility. Costs of up to $100 a tonne for incineration would not be unusual, converting to about $90 per cubic metre at 900kg/cubic metre density. For example, the Perth Solid Waste Study reviewed incineration costs and determined that a new incinerator in Hawaii was operating at a cost of $105 per tonne.

The long-term proposal to reuse greenwaste would significantly reduce the calorific value of the waste, necessitating fuel supplements, particularly in wet weather periods.

11.2. Pit Burners

Pit burners are used as a relatively low cost method of burning selected waste, building materials and timber. They are cheaper than incinerators, however the exhaust gases are less controllable. Pit burners can reduce the volume of waste requiring landfill significantly, however, not to the extent of incineration. Operation in protracted wet weather would be difficult. .

Due to the difficulties in meeting exhaust gases emission requirements and expected public objection to the odours and visible plumes which would result, a pit burner system was not considered viable for the total waste stream. It may be appropriate for large timber pieces and tree stumps, especially following any natural disasters.

11.3. Baling

Baling domestic waste is a technique similar to compaction and uses pressure to bind the waste into a tight mass ready for disposal. This process significantly reduces the volume of waste and makes handling and transportation easier. However, baling plants are costly to purchase and operate. They are also prone to mechanical breakdown due to the highly variable nature of the waste stream, including items such as large metal off-cuts and rocks. The baled contents of the landfill take longer to degrade and stabilise, thereby making the aftercare and utilisation of the site more difficult.

It was considered that baling of waste was not an economically viable option in the study area, especially given the relative closeness of the landfill to the city meaning haulage is already efficient.

11.4. Composting

See separate chapter above.

11.5. "Zero Waste" Integrated Approach

A number of such schemes are in various stages of operation or development globally. Such a scheme involves is a multitude of components to theoretically manage all waste streams resulting on no residual waste mass.

In summary the zero waste approach has the following components:

- Receivals area where large objects are removed;
- A system to break open any bags;
- A trommel screen to separate out small components which are usually the organics;
- Magnets and Eddy current systems to remove all metals;
- Manual segregation of the remaining waste into various recyclable components;
- An organics composting facility;
- A compost screening, drying and bagging process;
- An incineration system for plastics and other inorganic waste;
- A brick making facility to utilise the ash from the incinerator;
- A crusher to allow a recycling of construction and demolition waste; and
- Appurtenant works such as gas scrubbers and other odour control systems.

The aim of such facilities is very clear, that is, to have a zero waste operation. Such zero waste facilities are the ultimate aim for all Waste Management operations but to date have not succeeded in a sustainable way anywhere globally in a traditional community setting. There have been many pilot and short-term trials which have the theoretically achieved a zero waste position, but none in a sustainable real world application.

In reality however the long term expectations are not positive because of operating costs for energy alone as well as maintenance costs for all the mechanical equipment which is operating in a very harsh environment. Also high level of operator skills are required to operate the facility as well as maintain the equipment, especially items such as incinerators.

The key issues regarding sustainability are on-going funding and plant complexity. Experience indicates that such funding often tails away when higher priority local funding requests eventuate, usually associated with higher profile local authority activities.

In summary, it is simply impossible to recycle or reuse every component of a real-world mixed domestic waste and commercial/industrial waste stream. Even internally to the ISWM operation, composting is not a completely predictable activity. Compost facilities utilising more traditional waste streams like green waste or sewage sludges --always have some batches that do not meet specification for some reason either biological or due to contamination. These off-specification batches have to be dumped and there is no facility at this style of plant for such a large volume to be disposed of.

11.6. International Comparisons

There are no functioning full scale MSW compost schemes operating in developing countries in SE Asia which are self-funding. All have failed through a lack of a viable market for the product, lack of funds to continue operation (as they are not self-funding) or ultimately conversion to composting other more suitable material such as animal manure. A large scheme handling 1000t/d operates in Lahore but that is a PPP arrangement where compost contamination is not an issue (as one of the PPP partners is the adjacent farmer using the compost and he does not mind if the compost has foreign objects therein) and finally compost is applied to high value food crops.

Waste incineration is generally only practiced in locales where land costs are so high to preclude landfill development. They are banned in some counties like the Philippines because of concerns about the stack emission being environmentally damaging and even carcinogenic. The Government there does not believe that incinerator scrubber and filter systems will be maintained in the long term thereby allowing toxins to escape into the atmosphere.

The unfired bricks can only be used for local non-structural drainage projects which will eventually be fulfilled. Also incinerator ash can contain many contaminants such as heavy metals. Unless a pozzolanic material such as cement is added to the mix, then the heavy metals will be mobile and can leach out causing pollution.

11.7. Summary

Most of the above methods can be used for reduction of the volume of waste; however a landfill is still required for some part of the waste stream.

A typical zero waste approach is considered very unlikely to be sustainable for the many reasons listed above. The high capital and operating cost of such a process makes the process nonviable unless the provincial or national government is committed to subsidising the operation for the life of the operation.

Given the cost of the above methods, landfilling is considered the most appropriate method for disposal. Only the remnant wastes will be landfilled.

12. Waste-to-Energy

12.1. Technology Review

A range of technologies are available for each of the thermal treatment processes. Those that will be reviewed for the purpose of this comparative assessment are:

- **Moving Grate Incineration**
- **Fluidised Bed Incineration**
- **Rotary Kiln Incineration**
- **Gasification**
- **Plasma Gasification**
- **Pyrolysis** (conventional pyrolysis)

12.1.1. Moving Grate Incineration

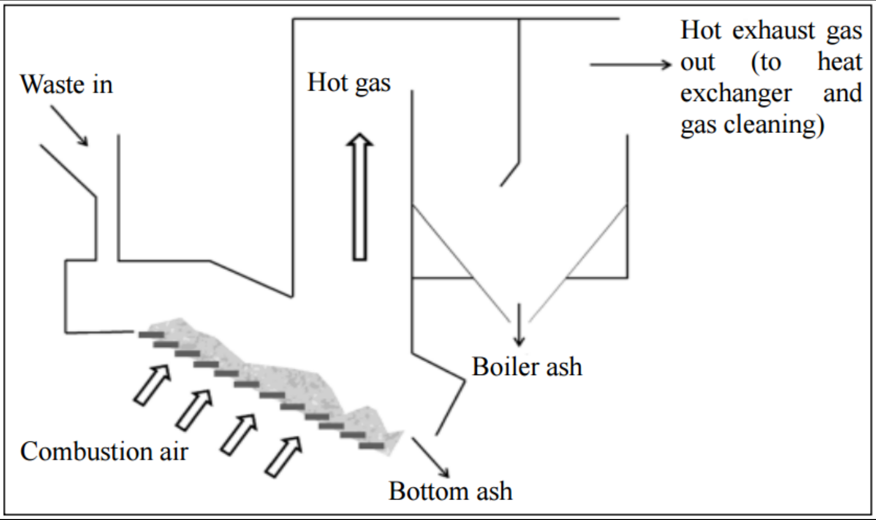
Moving Grate Incineration (see **Figure 12-1** and **Table 12-1**) is an incineration system equipped with an inclined moving grate system which keeps the waste moving through the furnace during the combustion process. It is one of the most widely used MSW incineration technologies worldwide with an extensive commercial track record. The moving grate system has high efficiency to operate regardless of the composition, calorific value and moisture content of the MSW. Therefore the MSW feedstock does not require extensive pre-treatment before undergoing the incineration process.

In comparison with other thermal treatment technologies, the plant capacity of the moving grate incineration system is the highest, which range from 20 to 4,300 tpd of mixed MSW, respectively. Moving grate incineration system is the only system which has been thoroughly proven to be capable of treating over 3,000 tpd of mixed MSW without requiring any pre-treatment or pre-processing to achieve a homogeneous waste nature.

Process:

- Feeding hopper is filled with MSW, which seals the furnace from the outside and prevents backfire.
- MSW is fed via the chute into the grates. The grate is made up of moving parts, which push the waste through the combustion by grate movement.
- Primary air is injected through the grate from below and secondary air is injected above the grate into the flame region. MSW is first dried on the grate and then combusted at high temperatures (typically 850 – 950°C)
- Heated flue gasses are passed to a heat recovery boiler.
- IBA is transferred from the discharge chute into a quench bath for cooling before further disposal.

■ **Figure 12-1: Schematic Diagram of Moving Grate Incineration Process**



Source: Harrison, R.M. (2014).

Table 12-1: Technology Characteristics – Moving Grate Incineration

PARAMETER	DESCRIPTION
Process Type	Thermal, Direct Combustion, Excess Oxygen
Typical Feedstock	Raw MSW
Track Record	Strong
Plant Capacity	20- 4,000 tpd
Pros	• Large treatment capacities (up to around 4,000 tpd). • Mature technology with worldwide application and with extensive commercial track record. • High reliability and comparatively low maintenance costs. • Little / no pre-treatment of MSW required • Flexibility regarding variations in calorific value and moisture content. • Low levels of particulates in flue gas. • Well-developed environmental/emissions controls systems widely available. • IBA (Incineration Bottom Ash) is sterile, and recycling of metals from IBA is possible.
Cons	• Not suitable for liquids or powders. • Heat exchange may not be even, resulting in hot and cool spots within the waste stream. • Energy recovery efficiency is not as high as some other systems (e.g. fluidised bed filter). • Combustion residues may become melted to the grate, requiring periodic cleaning. • Waste gases produced when incinerating MSW typically include NO_x, dioxins and furans; therefore effective emissions control systems are required.

12.1.2. Fluidised Bed Incineration

Fluidised Bed Incineration (see

Figure 12-2 and **Table 12-2**) is an alternative design to conventional combustion system in which the moving grate is replaced by a floating bed of granular materials, such as sand, which can understand high temperatures. There are two main types of fluidised bed: bubbling and circulating bed types.

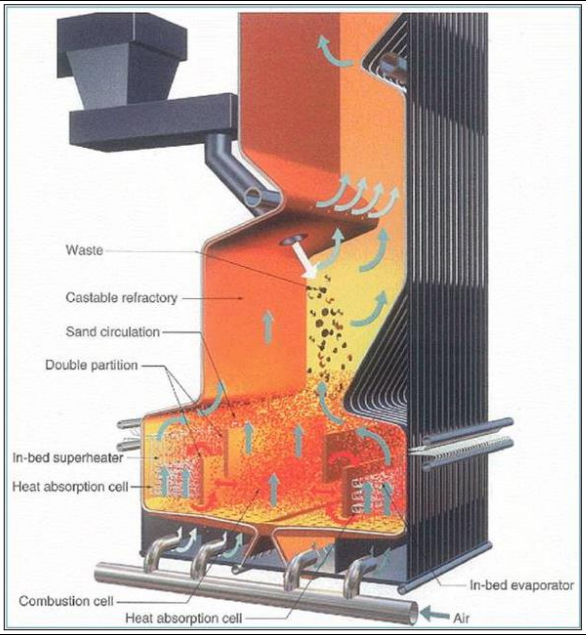
The pre-treatment of MSW is required in this system, usually by shredding, drying and pelletizing. The process efficiency may also be improved by co-combusting waste with other homogenous, high-calorific materials such as coal or woodchip.

The application for waste combustion using fluidised bed only began around 50 years ago. This included treatment of sewage sludge, as well as industrial and municipal wastes such as plastics, paper and tires (all of which had to first be processed and homogenised). Comparing to moving grate incineration, the fluidized-bed incineration system generally offers more uniform mixing, longer residence time (typically 4-5 seconds) and better residue burnout (typically less than 1% unburned carbon).

Process

- The MSW are shredded, dried and pelletized before introducing into the system
- An air distribution system forces large volumes of air through the sand bed, causing it to circulate and become partially suspended, thereby acting in a fluid-like manner.
- The processed MSW is introduced and combusted as a result of the elevated temperature and available oxygen (air temperature is typically 850-950°C, whilst sand bed temperature is typically 600°C)
- The incineration process is controlled by varying the waste feed rate and the air flow rate to the furnace.
- If combustion is interrupted for a short period of time, the sand bed temperature is typically maintained at 450-550°C which allows quick recovery to full operating temperatures.
- Ash is discharged through the base of the combustion chamber.

▪ **Figure 12-2: Typical Fluidised Bed Incineration Process**



Source: SSWM Toolbox

▪ **Table 12-2: Technology Characteristics – Fluidised Bed Incineration**

PARAMETER	DESCRIPTION
Process Type	Thermal, Direct Combustion, Excess Oxygen
Track Record	Medium to Strong
Typical Feedstock	Treated RDF, sludge or other homogenous fuel such as wood chip or coal
Plant Capacity	20-1,600 tpd
Pros	• The waste is mixed and heated up evenly, allowing even incineration process • Particularly effective for incineration of high calorific value wastes. • Higher energy conversion efficiency when compared with moving grate systems. • Less NO_x production when compared to moving grate systems. • IBA produced is sterile.
Cons	• Requires extensive pre-treatment of wastes, usually by shredding, drying and pelletizing. • Might consider co-combusting waste with other fuel sources such as coal to improve efficiency. • Limited flexibility for managing variations in waste composition. • Larger volumes of fly-ash created when compared to moving grate. • High parasitic energy load. • High particulate load in flue gas.

	• Comparatively high maintenance requirements when compared to moving grate systems (due to wear of the internal cylinder caused by the circulated sand bed and waste feedstock.)

12.1.3. Rotary Kiln Incineration

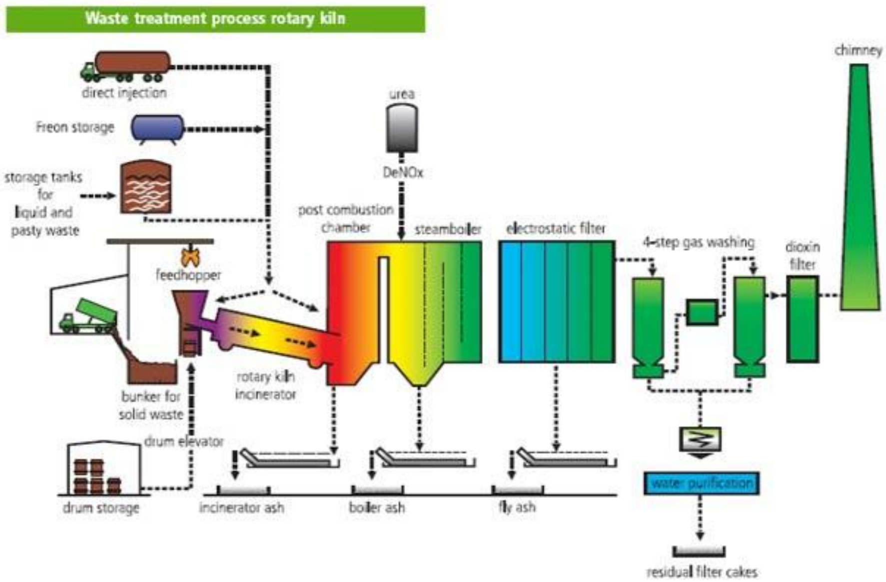
Rotary Kiln Incineration (see **Figure 12-3** and **Table 12-3**) typically consists of two linked chambers – a primary chamber and secondary chamber. The primary chamber comprises of a rotating steel cylindrical shell lined with an abrasion-resistant refractive layer. The rotary system can achieve two objectives simultaneously using rotating motion: (i) moving wastes through the high-temperature combustion zone, and (ii) mixing and stoking the wastes during combustion. The secondary chamber is used to complete gas phase combustion reactions and burns the gaseous by-products from the primary chamber.

The rotary kiln incineration system provides good mixing and stoking of wastes, along with a high level of control of waste residence time; thereby resulting in more complete combustion. A significant advantage of rotary kiln is no waste pre-processing is required, and it is able to handle both liquids and solids. It is therefore commonly used to treat hazardous wastes, including high-energy liquids. However, it has higher maintenance requirements than moving grate systems, and capacity is restricted by limitations in drum size. Energy recovery efficiency is also lower as heat is lost through the metal shell of the rotating drum.

Process

- Wastes and air are injected into the heated rotating primary combustion chamber.
- Chamber rotates to mix/stoke wastes and move them through the combustion zone.
- Gaseous by-products are also formed through volatilization, destructive distillation and partial combustion reactions, and these are passed to a secondary "afterburner" chamber to allow combustion of gases
- Heated flue gasses are passed to a heat recovery boiler
- Ash is excavated from the lower end of the kiln

▪ **Figure 12-3: Typical Rotary Kiln Process**



Source: Waste to Energy International

Table 12-3: Technology Characteristics – Rotary Kiln Incineration

PARAMETER	DESCRIPTION
Process Type	Thermal, Direct Combustion, Excess Oxygen
Track Record	Strong
Typical Feedstock	Solid or liquid wastes including hazardous wastes
Plant Capacity	20-144 tpd
Pros	• Little / no pre-sorting of wastes required. • Versatile, with the ability to deal with liquids and solids, as well as variations in moisture content and calorific value. • Ability to effectively control residence time, resulting in thorough burnout of waste • Particularly effective for treatment of hazardous waste streams, including high-energy liquids. • IBA is sterile.
Cons	• Regular maintenance of primary kiln is required, which increases OPEX. • Lower throughput in comparison to the moving grate system. • Low energy efficiency due to heat loss from the metal shell of the kiln. • Feeder end of kiln may be cooler than other portions, and may result in build-up of incompletely combusted residues such as melted plastic. • Limited capacity when compared with moving grate systems. • High particulate content in flue gas.

12.1.4. Gasification

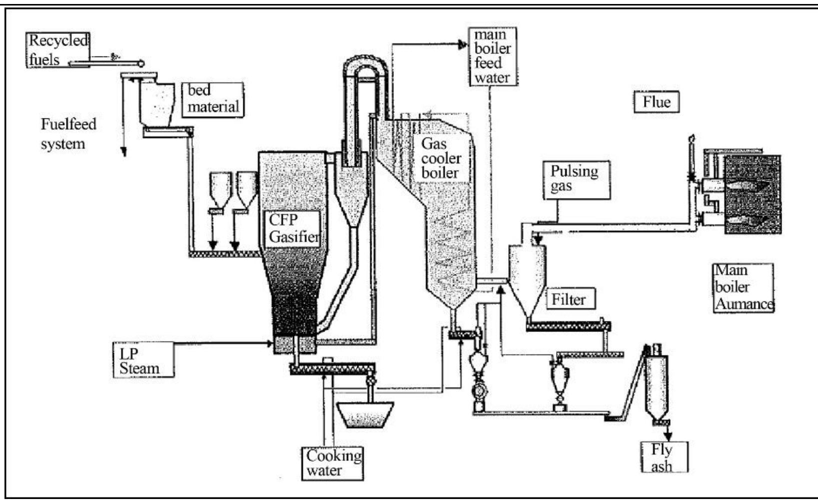
Gasification (see **Figure 12-4** and **Table 12-4**) is an incomplete oxidation of organic compound and convert combustible waste to syngas or producer gas at temperature in the range of 500–1800 °C. Syngas comprises carbon monoxide, hydrogen, methane, carbon dioxide, water, nitrogen, argon, solid carbon and contaminated substances such as tar, particulate, chloride, alkali metals and sulfide.

The amount of air pollution substrates, particularly dioxins and furans, emitted from gasification typically reported to be less than incineration. Furthermore, the types of air pollution control devices may be similar, but smaller than incineration. This shows higher efficiency and energy recovery along with lower investment cost than that of incineration. Therefore, gasification technology has high potential to treat MSW in the future because of easy handling and burning of syngas, efficient conversion, low air pollution substrates, as well as the capability to scale-down the technology. However, the current gasification plants in operation have a much lower unit and plant capacity than the moving grate incineration plants for mixed MSW treatment in which their plant capacity generally range from 100 to 450 tpd, respectively.

Process:

- The MSW is pre-processed first, sorting out the recyclables
- The MSW feedstock is then heated up in the reactor, with limited supply of oxygen/ air
- The Syngas is collected from the chamber and is typically passed to a combustion turbine where it is combusted to produce energy.
- Additional processes for further “cleaning” of the Syngas may be required to improve combustion efficiency and remove contaminants.

Figure 12-4: Typical Gasification Process



Source: Natural Science

Table 12-4: Technology Characteristics – Gasification

PARAMETER	DESCRIPTION
Process Type	Thermal, By-Product Combustion, Low Oxygen
Track Record	Limited
Typical Feedstock	Shredded waste
Plant Capacity	100-450 tpd
Pros	• Little/no waste ash produced. • Suitable for the treatment of medical or hazardous wastes. • The End products of the process has a higher economic value and has the potential to be further processed into other products such as chemicals, fuels • Syngas can be stored and used for other industrial processes (e.g. production of gasoline) in addition to being combusted directly for energy. • No waste flue gas production.
Cons	• High parasitic energy load (i.e. the energy required to keep the process running). • Complex process to manage and difficulties in optimising (however can be very effective once optimised). • Requires pre-treatment of waste. • Limited capacity to cope with variations in waste composition. • Limited commercial track record for MSW treatment.

12.1.5. Plasma Gasification

Plasma Gasification (see **Figure 12-5** and

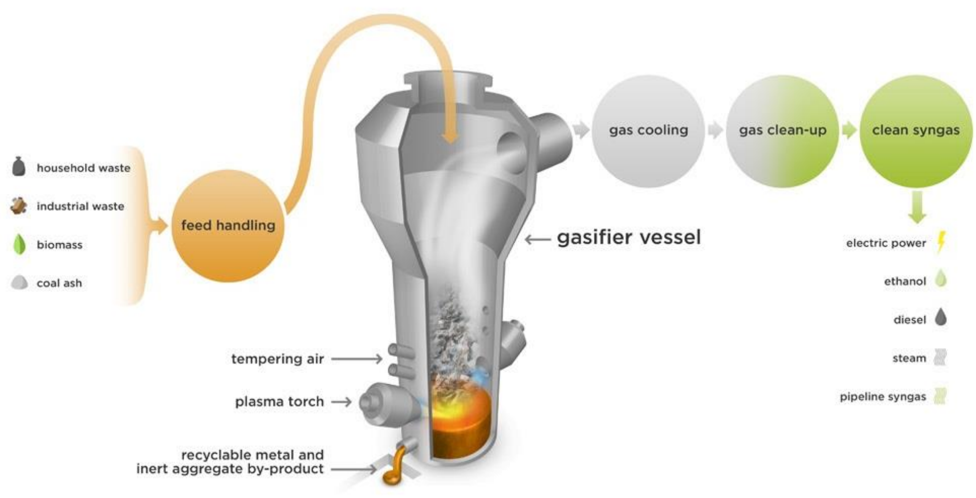
Table **12-5**) is a more recent advent in waste treatment technology. It entails the chemical decomposition of waste in a low-oxygen environment, utilising a high-temperature plasma torch. The temperature of the plasma arc typically ranges from 2,700 to 4,400°C; however instances of temperatures up to 10,000°C have been reported. Plasma gasification plants have a comparatively low capacity range (between 20 and 500 tpd), and at present have not been widely-adopted for MSW treatment.

Little or no ash is produced since the carbon-based wastes are completely vaporised, and any non-carbon-based substances such as metals, glass or concrete are melted and turned into slag (for metallic components) or vitrified glass (for silica-based components). No flue gas is produced as the vapour by-products are captured as Syngas, which can be combusted to generate electricity or used as a reagent in other industrial processes.

Process:

- Pre-treated waste is fed into a vertical, cylindrical combustion chamber which has a low-oxygen atmosphere.
- The waste is passed through the arc of an electrically-driven plasma torch, within which it is vaporised to form Syngas.
- The Syngas is collected from the chamber and is typically passed to a combustion turbine where it is combusted to produce energy.
- Additional processes for further "cleaning" of the Syngas may be required to improve combustion efficiency and remove contaminants.
- The remaining slag is collected through an outlet at the base of the chamber.

Figure 12-5: Typical Plasma Gasification Process



Source: Alliance Federated Energy

Table 12-5: Technology Characteristics – Plasma Gasification

PARAMETER	DESCRIPTION
Process Type	Thermal, By-Product Combustion, Low Oxygen
Track Record	Limited
Typical Feedstock:	Shredded waste
Plant Capacity	20-500 tpd
Pros:	• Little/no waste ash produced. • Suitable for the treatment of medical or hazardous wastes. • Good potential for metals recovery/recycling from slag/vitrified residues. • Syngas can be stored and used for other industrial processes (e.g. production of gasoline) in addition to being combusted directly for energy. • No waste flue gas production. • Vitrified slag is largely inert so there is little potential for contaminant leaching.
Cons:	• High parasitic energy load (i.e. the energy required to keep the process running). • Complex process to manage and difficulties in optimising (however can be very effective once optimised). • Requires pre-treatment of waste. • Limited capacity to cope with variations in waste composition. • Limited commercial track record for MSW treatment. • Process wastewater may be contaminated by carcinogenic or toxic compounds formed during the production of Syngas. • Syngas may require extensive contaminant removal before it can be combusted. • High CAPEX and OPEX costs when compared to direct combustion technologies. • Limited workforce with suitable skills available.

12.1.6. Pyrolysis

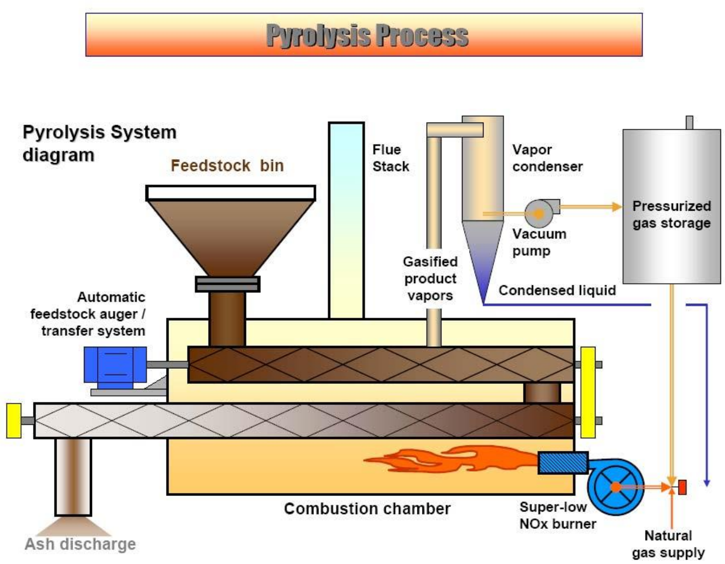
Pyrolysis (see **Figure 12-6** and **Table 12-6**) is an anaerobic indirect-heat process in which organic waste is decomposed to produce oil, carbonaceous char and combustible gases. These by-products are used as a fuel source and are burned to generate heat. Since no oxygen is required in the pyrolysis process, the volume of flue gas generated is lower than incineration and gasification processes. Unlike incineration and gasification systems, which are self-sustaining and use oxygen for waste combustion, an external source of heat is required to drive the pyrolysis reaction. Relatively low temperatures (in the range of 400 to 800°C) are required for pyrolysis. Pre-preparation of the MSW is also required.

Pyrolysis is not yet widely used as a treatment technology for MSW, and there is currently limited information available for review as many projects are still in the pilot stage. Challenges include low energy production (due to the amount of energy required to power the process), difficulties in process optimisation and safety concerns.

Process

- Processed MSW is placed into an airtight hopper
- Waste is transferred from the hopper to a reaction chamber where it is heated in the absence of oxygen and is converted to char, pyrolysis oil and pyrolysis gas (lower temperatures favour formation char and pyrolysis oil, and higher temperatures encourage formation of pyrolysis gas).
- Pyrolysis oil is collected for combustion or for use in other processes, and solid residues are separated.
- Solid residues containing high carbon content may be subjected to an additional treatment.

Figure 12-6: Typical Pyrolysis Process



Source: Waste to Energy International

Table 12-6: Technology Characteristics – Pyrolysis

PARAMETER	DESCRIPTION
Process Type	Thermal, By-product Combustion, No Oxygen
Track Record	Limited
Typical Feedstock	Processed MSW
Plant Capacity	100-500 tpd
Pros	• Pyrolysis oil can be stored and used in other potential industrial applications in addition to combustion for WTE (e.g. production of bio-diesel). • Lower flue gas emissions than conventional combustion technologies. • Particularly effective for volatile, high-energy waste fractions.
Cons	• Require pre-treatment of wastes. • Pyrolysis oil typically contains toxic and carcinogenic compounds. • Solid residue may not be completely combusted. • Low overall energy efficiency. • Limited track record for MSW management. • Solid residues may have high heavy metal content. • Additional treatment may be required to produce a sterile IBA.

12.2. Comparative Summary of Selected Thermal WTE Technologies

Sections **12.2.1** - **12.2.6** provide a comparative review of the key characteristics of the selected thermal WTE processes and technologies, which is in turn summarised in **Table 12-7**.

- **Table 12-7: Comparison Summary of Selected Thermal of Treatment Technologies**

PARAMETER	MOVING GRATE INCINERATION	FLUIDIZED BED INCINERATION	ROTARY KILN INCINERATION	GASIFICATION	PLASMA GASIFICATION	PYROLYSIS
Plant Capacity Range	200-4,000 tpd	20-1,600 tpd	20-144 tpd	100-450 tpd	20-500 tpd	100-500 tpd
Waste Type	Solid only	Solid and sludge	Solid, sludge or liquid	Solid or liquid	Solid or liquid	Solid or liquid
Flexibility	High	Low	Medium	Low	Low	Low
Energy Gen. Efficiency	Medium	High	Medium	High	High	Low
Relative Facility Size	Large	Large	Large	Medium	Small	Small
Relative CAPEX	Low	Medium	Low	Medium	High	High
Reliability	High	High to medium	High to medium	Low	Low	Low
Relative OPEX	Low	High	Medium	High	High	Medium
Track Record for MSW	Strong	Moderate	Moderate to strong	Limited	Very limited	Very limited
Flue Gas Emissions	Medium	High	High	Low	Low	Low
Requires Pre-Treatment	No	Yes	No	Yes	Yes	Yes

Engineering Factors

12.2.1. Flexibility in Waste Composition

Moving grate incineration technology possesses a high level of flexibility to deal with variations in waste quality and composition. It also does not require pre-processing of MSW, such as shredding or grinding, whereas this is a requirement for other systems apart from rotary kiln incinerators. Moving grate incineration is also flexible in terms of treatment capacity, with effective facility sizes ranging from 20 to 4,000 TPD.

A limitation to moving grate technology is that it can only handle solid, non-powdered waste. Rotary kiln incineration has the flexibility to deal with both liquid and solid waste; however its capacity efficiency is lower than that of the moving grate. The other technologies reviewed all require varying degrees of waste pre-treatment.

12.2.2. Electricity Production Efficiency

The greatest potential energy recovery efficiency is from both gasification and plasma gasification as the chemical energy from MSW is converted into Syngas. This Syngas can be sent to a combustion turbine where the energy released during combustion directly powers turbines. This potential energy recovery efficiency is however offset by a relatively high parasitic energy load (i.e. the energy required by the process), meaning that in practice the comparative efficiency is much lower.

For conventional incineration systems (moving grate, fluidised bed and rotary kiln), energy in the MSW is recovered through a near complete waste burning process and the heat energy is then diverted to waste heat boilers to generate steam for electricity generation using steam turbines. This process results in greater heat loss as the energy is exchanged between the various systems, and so has less efficiency potential than gasification.

The lowest energy recovery potential at present is from pyrolysis due to the large amount of carbon which is often not fully converted, as well as the high energy input requirements needed to sustain the process.

12.2.3. Reliability and Track Record

Broadly-speaking, the greatest operational reliability at present is provided by moving grate incineration systems. These are by far the most widely used technologies for both energy recovery from MSW, as well as incineration without energy recovery. They have been proven to be robust and easy to maintain in comparison to other technologies.

Arguably, the lowest reliability and weakest track record for MSW treatment is currently provided by pyrolysis and plasma gasification technologies as these are still in a development phase and with limited track record.

12.2.4. Land Requirements and System Complexity

The possible land requirements for the various technologies are subject to the number of units needed to treat the target waste load of MSW, as well as the footprint size of the various units. The moving grate incineration plant occupies a large footprint; however each process unit has a large treatment capacity. Therefore a smaller number of units are required to deal with a large volume of waste. In contrast, gasification, pyrolysis and plasma gasification units occupy a relatively smaller footprint; however each unit has limited treatment capacity, thereby requiring a larger number of units to be installed.

As such, if incineration of large volumes (e.g.: 500 or more tons per day) of MSW is required, moving grate and fluidized bed facilities frequently provide an optimal combination of treatment capacity in comparison with the required facility footprint.

12.2.5. Capital and Operating Costs

CAPEX and OPEX costs vary significantly across projects, countries and regions, and thus a relative ranking has been provided rather than absolute cost ranges. When considering cost efficiency (i.e. the treatment capacity in comparison with CAPEX and OPEX investment), the most efficient systems are often moving grate incineration. This is because of their large treatment capacity (reducing the number of treatment units required), relative operational simplicity, and widespread application. Additionally this technology does not require pre-treatment of wastes thereby further reducing OPEX costs.

The lowest cost efficiency is typically realised with pyrolysis and plasma gasification systems as these are relatively recent innovations for MSW treatment, and many functioning units are prototypes. As such their development and maintenance is expensive when compared to conventional combustion technologies. Additionally the process units have limited capacity, thereby increasing the number of units are required to manage a given volume of waste. Under these circumstances, moving grate incineration remains as the most favourable option as it has the low CAPEX and OPEX.

Environmental Factors

12.2.6. Air Emissions

Plasma gasification generally generates a lower volume of flue gas and associated pollutants than other incineration technologies since the vapours are largely captured in the Syngas. The low oxygen, high-temperature environment also significantly retards the production of dioxins and furans. Syngas often undergoes a “cleaning” process to remove toxic contaminants, and if this is done effectively it burns cleanly to produce CO_2 and water vapour.

When comparing direct combustion technologies (namely moving grate, rotary kiln and fluidised bed), the lowest volume of flue gas emissions are produced by moving grate incineration. These emissions may contain various toxins and pollutants, and as such the application of appropriate APC technologies are required to reduce these emissions.

12.3. Technology Recommendation

After screening out rotary kiln incineration, plasma gasification and pyrolysis technologies, an evaluation of the moving grate incineration, fluidized bed incineration and gasification technologies are carried out, based on the environmental, engineering and cost criteria set out in **Table 12-7** with specific consideration of the feed-stock types, energy desired, end use requirement, pollution control standards, economic performance and other locally specific factors.

Closing non-sanitary dumpsites and promoting waste recovery are the main MSW management strategies of the Philippines. Payatas Landfill, the existing waste disposal site for QC which receives about 1,700 tpd of MSW from the city is not well-engineered and expected to be closed down by February 2019 if there is no extension or modification. Based on the discussion with Quezon City Environmental Protection & Waste Management Department (QCEPWMD) in August 2016, the City Government, is considering proposals from WTE companies or other interested investors such as the French Government and Japan's Ministry of Environment to develop the Payatas Landfill into a WTE facility.

As the treatment capacity of gasification is normally limited to below 450 tpd, and the commercial operation of gasification technology does not have a sound track record yet due to technical and economic difficulties, the incineration technologies which are able to stably process over 1,700 tpd of MSW shall be more appropriate to be considered by the City Government.

Air emission control could be a main challenge of introducing incineration technologies to QC. The Philippines have issued the Clean Air Act of 1999 (Republic Act No. 8749), which prohibits incineration that emits poisonous and toxic fumes. Upon discussing with QCEPWMD, it was clarified that incineration technologies could be accepted as long as the proposed technology complies with the stringent air emission standard in the Clean Air Act. In response to the standard, effective flue gas treatment systems shall be applied. Fluidized bed incinerators normally generate 15-25% more fly ash than moving grate reactors, which causes higher flue gas emission and thus making compliance with the standards in the Clean Air Act more challenging. Moreover, about 25% of coal is used by the technology as supplementary fuel, which may worsen its environmental impact. Also, extensive pre-treatment will be needed for fluidized bed incinerator which adds up capital and operation cost, whilst minimum pre-treatment procedures, if any, is required by moving grate incinerators as long as the gross heating value is sufficient.

As a result, moving grate incineration is a suitable WTE solution for QCEPWMD. The advantages of moving grate incineration are summarized as follows:

- Quezon City has a amount of MSW up to 1,700 tpd, where moving grate technology is capable of processing such tonnage of waste with reliable performance;
- The waste of Quezon City has elevated moisture content and heterogeneous composition. Moving grate technology shows the highest capability to tolerate the fluctuation of MSW characteristics, with robust performance when handling mixed MSW, whereas operation of the other two technologies require pre-treatment of MSW;
- Moving grate incineration have a strong track record during the past decades, while there is a concern for operation failure of the gasification technology due to the unpleasant experience in Germany; and
- Moving grate incineration has a better environmental performance than fluidized bed technology with widely available pollution control technologies.

12.4. Preliminary Recommendations for the Proposed WTE Project

Based on the aforementioned technological review and in response to the request from the QCEPWMD on technical aspects of the new WTE development, the Consultant has come up some preliminary recommendations on the site selection, project design, CAPEX and OPEX as well as contractual structure for the potential moving grate incineration project.

The suggested WTE facility will apply moving grate incineration technology. As this is the first MSW incineration project in QC, it is proposed that the development will be divided into two phases, in which phase I development will possess the MSW treatment capacity of 1,000 tpd and that of the phase II incinerator is 700 tpd. The key rationales for this phased arrangement are to:

- Reduce upfront investment and hence capital risk of the overall WTE project;
- Reduce the financial risk during project operation period due to uncertain tipping fee;
- Serve as trial operation before commencing full scale operation so as to collect operating data to fine tune the overall facility; and
- Provide buffer time for the transformation of MSW management approach (from landfill disposal to waste incineration).

It is suggested that the facility would be developed and operated by a project company under PPP agreement. The estimated average surplus electricity supplied to the grid of Quezon City shall be at a minimum of 300 kWh per tonne of MSW treated. The facility is estimated to operate for a period of 20 years.

12.4.1. Site Location

The MSW to be treated by the proposed facility would be primarily sourced from the waste that originally goes to Payatas Landfill of QC. The proposed facility is planned to develop on a site within or extended from the Payatas Landfill, which is currently owned by the local government unit (LGU) of QC, with an area of approximate 7 hectares for a 1,000 tpd moving grate incineration plant. It is believed that the proximity of the potential site to the existing landfill can reduce transportation cost of incoming waste. However, it should be noted that if the new WTE facility is to be developed on a historical dumping area, further study on the geotechnical feasibility and remediation procedure should be carried out. The site is already accessible by main roads, where the existing road condition could support long trailer trucks. The location of the site in relation to major townships and vicinal main roads are provided in **Figure 12-7** andError! Reference source not found. respectively.

■ **Figure 12-7 Location of Site in Relation to Nearby Townships**

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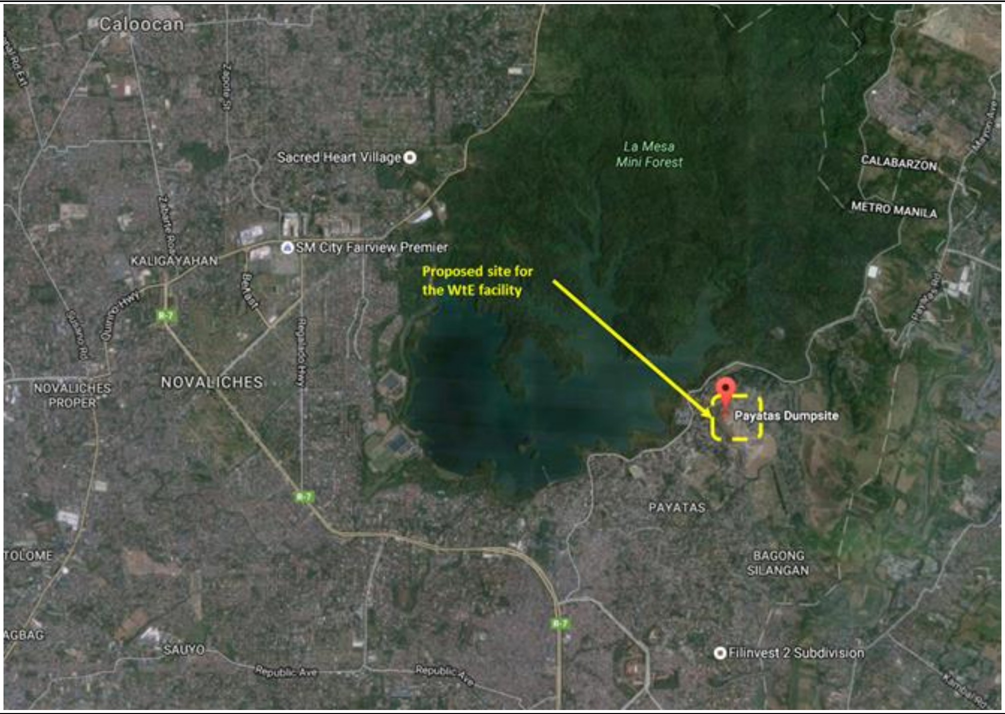

Source: Google Map

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■ **Figure 12-8 Access Roads nearby the Proposed Site**

Source: Google Map

12.4.2. Plant Design and Relevant Criteria

Key Features

This session lists out some of the key features in the preliminary design of the proposed facility. The capacity of the facility is divided into two phases: 1,000 tpd and 700 tpd. It is worth to note that these are average treatment capacities. The proposed facility would receive incoming MSW throughout the year, while the incinerator would operate with a minimum of 8,000 hours per year. This criterion provides sufficient amount of time for the facility to conduct maintenance works for the incinerators. The flue gas emission of the facility has to comply with prevailing national standards of the Philippines such as Clean Air Act 1999 (Republic Act No. 8749). In terms of power generation, the estimated electricity generated should exceed 300 kWh/t, whilst the surplus electricity shall be transferred into the local electricity grid. The key features of the preliminary design are listed in **Table 12-8**.

- **Table 12-8 Table 12-9 Key Features of the preliminary design of the Proposed Facility**

Items	Performance Requirement
Average Treatment Capacity	Phase I: 1,000 tpd; Phase II: 700 tpd
Technology	Moving grate incineration
Availability of Incineration System	Minimum: 8,000 hours per year Receiving waste: 365 days per year (or 366 days per leap year)
Air Emission	Comply with the prevailing national standards as per the EIA Report
Power Generation	Average surplus electricity generated per tonne of waste incinerated: 300 kWh/t (min.)
Combustion Efficiency	Loss on ignition <5%

The proposed moving grate incineration facility should include the following key components:

<u>Incineration Plant</u>

- MSW receiving, storage and feeding system
- Moving grate incineration furnaces
- Waste heat recovery and power generation system
- Flue gas control and monitoring system
- Ash Storage and handling system
- Reagent reception and storage system
- Odour control system
- Process control system

Ancillary & Supporting Facilities

- Leachate treatment plant
- Weighbridge
- Site security
- Administration building
- Vehicle washing facilities
- Maintenance workshop
- Electricity supply and export system
- Utilities

Waste Characteristics

The MSW characteristics data of Quezon City have been obtained from QCEPWMD and is presented in Error! Reference source not found.**.** The key characteristics of the mixed MSW including composition, moisture content, ash content and gross heating value.

Detailed waste audit is expected to be conducted by the Consultants in late 2016. Therefore current waste composition data only serve as a reference for the project design and will be subject to changes.

Table 12-10 Waste Composition of Quezon City

Type of Waste	Waste Composition (%)	HHV (Gross Heating value) (MJ)	Moisture Content (%)
Putrescible Waste	35.7	6.778	59.85
Papers	14.4	10.693	38.11
Cardboard	3.1	12.309	30.34
Complex	4.7	19.967	12.67
Fibres	3.0	11.170	45.93
Sanitary Fibres	3.7	4.199	81.24
Plastics	17.0	27.876	18.14
Combustible not classified	14.5	10.287	44.65
Glass	1.3	-	-
Metal	0.8	-	-
Non Combustibles	1.4	-	-
Special household waste	0.1	-	-
Fine elements <8mm	0.4	-	-
Overall	-	12.001	42.33

Air Emissions

The proposed WTE shall be equipped with adequate air pollution control and monitoring systems which should comply with all the prevailing environmental legislations. An Environmental Impact Assessment (EIA) should be carried out before project construction to evaluate the potential environmental impact concerning air emissions and to determine the emission limits.

Effluent Discharge

An on-site wastewater treatment plant shall be provided for treating the leachate and other wastewater produced from the operation of the incinerators. Recycling of treated effluent from the on-site treatment plant for non-potable uses shall be deemed considered to minimize the ecological footprint. Environmental Impact Assessment should be carried out to evaluate the potential environmental impact concerning effluent discharge and to determine the applicable discharge standards.

Fly Ash and Bottom Disposal

The fly ash generated under normal operation of the proposed MSW incineration project should comply with the requirements stipulated in its EIA Report prior to disposal to designated landfill. Pre-treatment of fly ash may be required when the control limits of fly ash cannot be met. Recycling of bottom ash for brick-making shall be actively explored to optimize resource utilization.

12.4.3. Cost Estimations

The cost estimations of the moving grate incineration facility, including both CAPEX and OPEX, is listed in Error! Reference source not found. and Error! Reference source not found.[2].

- **Table 12-11 Cost Estimation of the Proposed Facility**

CAPEX items	Approximate %	Amount
Waste Reception, Incineration and Heat Recovery System	32%	US$ 75,200,000
Flue Gas Treatment and Ash Handling System	10%	US$ 23,500,000
Leachate Treatment System	6%	US$ 14,100,000
Building E&M, Process Control and Monitoring System	9%	US$ 21,150,000
Civil, Building Structural and External Works	25%	US$ 58,750,000
Others (incl. Preliminaries, Detailed Design, Construction Supervision etc.)	10%	US$ 23,500,000
Contingencies	8%	US$ 18,800,000
CAPEX total	100%	US$ 235,000,000

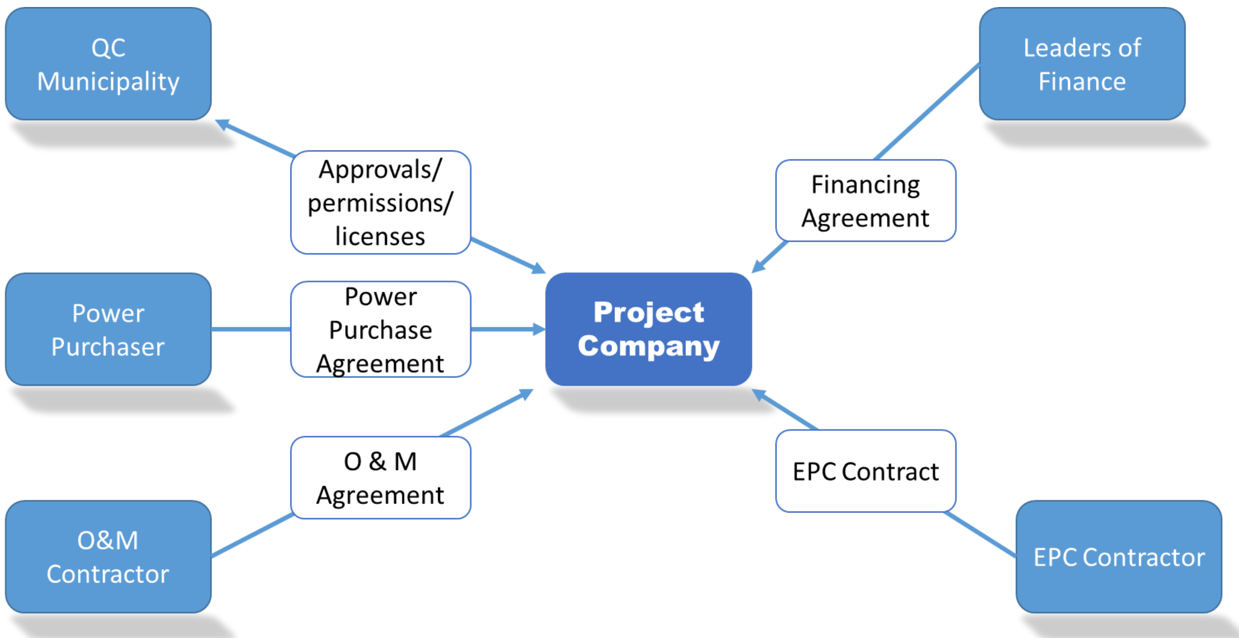
- **Table 12-12 OPEX estimation of the Proposed Facility**

OPEX items	Approximate %	Annual Expenditure
Chemical and consumables	10%	US$ 1,478,250
Operational staff	15%	US$ 2,217,375
Routine maintenance, repair and overhaul	35%	US$ 5,173,875
Treatment of leachate and ashes	20%	US$ 2,956,500
Utilities	10%	US$ 1,478,250
Others	10%	US$ 1,478,250
OPEX total **(i.e. US$ 41/tonne)**	100%	US$ 14,782,500

2 Any opinion expressed by AECOM concerning the revenue, CAPEX and OPEX is based on the generally accepted engineering practice in effect at the time of the assignment and information that has been supplied to AECOM by the Client and others in connection with the assignment. Any indication of cost would be in the form of an 'order of magnitude estimate', which should only be considered as an early indication of cost and in no case be considered as the actual costs. Such opinions are subject to risks and uncertainties that are beyond the control of AECOM. The passage of time may result in changes in technology, economic & market conditions, competitive factors, site variations, new products, company's policy or regulatory provisions which would render the opinions inaccurate. Thus AECOM makes no representations or warranties with respect to such opinion or recommendation and disclaim any responsibility for the accuracy and completeness of any opinion or estimates.

12.4.4. Operational Framework

- **Figure 12-9 BOT Framework for Incinerator development**



It is suggested that the incinerator would be operate under a BOT framework (See **Figure 12-9**). BOT is widely adopted in power generation sector in the Philippines after the enation of The Philippine BOT Law R.A. 7718. The main advantage of BOT is the government can utilize private sector's investment, management, and technology, the QC local government is familiar with this framework.

Currently, the Quezon City is considering proposals from various parties, including the proposal from Infrastructure conglomerate Metro Pacific Investments Corp, which aim to develop the Payatas Landfill into a WTE facility. Moreover, another WTE proposal suggested a project with a capital cost around USD 1.8 billion and the size of the project is about 10 hectares of land. The QC-LGU intends to have a possible joint venture with some companies involved in this kind of technology and is currently negotiating with them.

Under the BOT agreement, the QC municipality will authorize the project company to design, build and operate a project before finally handover to the government after the concession period, which usually lasts about 20-30 years. BOT allows the project proponents to earn a satisfactory return on the investment through receiving tipping fee from the government during the operation stage.

The consideration when the government establishes BOT agreement with the WTE project company are summarized in **Table 12-13**.

Table 12-13 Considerations for Concession Agreements for Moving Grate Incineration Facility

Aspect	Key Considerations on Contract Mechanism, Performance Standards and Requirements
Length of concession agreement	• Total number of years of the concession period (inclusive of construction period of about 1.5-2 years).
Exclusivity	• The granting of exclusive right to invest, build, operate and maintain the facility and treat the waste generated in the service catchment by the government. • Possibility of facility expansion when the amount of MSW arising has exceeded the treatment capacity of the facility.
Waste supply	• Possibility of guaranteed supply of a guaranteed minimum tonnage (GMT) of waste by the government. • Type of permitted waste.
Tipping fee	• The tipping fee per tonne and its adjustment policy.
Responsibilities of parties	For the government: • Provision of land and support in completing the approval procedures including but not limited to feasibility study, environmental impact assessment, planning, and permitting. • Construction of road and utilities connecting to the project boundary. • Supply of fresh water and process water for the facility's use. • Authority of supervision and/or carrying out inspection of design, construction and/or operation without interrupting the project company's progress. For the project company: • Preparation and submission of all the necessary reports / applications and obtaining approvals / permits from the responsible governmental authorities. • Investing, designing, constructing, testing and commissioning the facility, operating and maintaining the facility throughput the contract period and compliance with the prevailing standards and regulations.

Ownership	• Ownership of assets and facilities within the project area during and after the concession period.
Penalty	• Liquidated damages payable to the government due to any delays in construction and/or non-compliance in operation and pollution controls.
Handover	• Facility condition, coverage and compensation for project handover at the end of the concession period or at any such other time when the agreement is terminated prior to the end of concession period.

12.4.5. Preliminary Implementation Schedule

While the implementation of moving grate incineration project in QC should be subject to more detailed feasibility study, a preliminary action plan is presented in **Table 12-14**. Given the complexity of the proposed project in its implementation phase, a more detailed action plan is presented in **Table 12-15**

- **Table 12-14 Preliminary Implementation Schedule for Moving Grate WTE facility**

Phase and Step		**Purpose and Issues to Consider**	**Duration**
Feasibility Phase	Prefeasibility Study	Waste quantities, calorific values, capacity, siting, RDF sale, organization, costs and financing	3-6 months
	Political Decision	Consultation with local residents and stakeholders, decision on priority, financing and environmental requirements	3 months
	Feasibility Study	Waste quantities, calorific values, capacity, siting, energy sale, organization, costs and financing in detail	6 months
Project Preparation Phase	Tender and Financial Modelling	Detailed financial engineering, negotiation of loans or other means of financing, and selection of consultants	3 months
	Preparation of Tender Documents	Reassessment of project, specifications, prequalification of contractors and tendering of documents	6 months
	Political Decision	Decision on financial package, tendering of documents and procedures in detail and final go-ahead	3 months
Project Implementation Phase	Award of Contract and Negotiations	Prequalification of contractors, tendering of documents, selection of most competitive bid, contract negotiations	Please refer to **Table 12-15**
	Construction	Construction by selected contractor	
	Commissioning and Start-up	Testing of all performance specifications, settlements, commissioning, training of staff, and start-up by constructor	
	Operation and Maintenance	Continuous operation and maintenance of the facility, continuous procurement of spare parts and supplies	

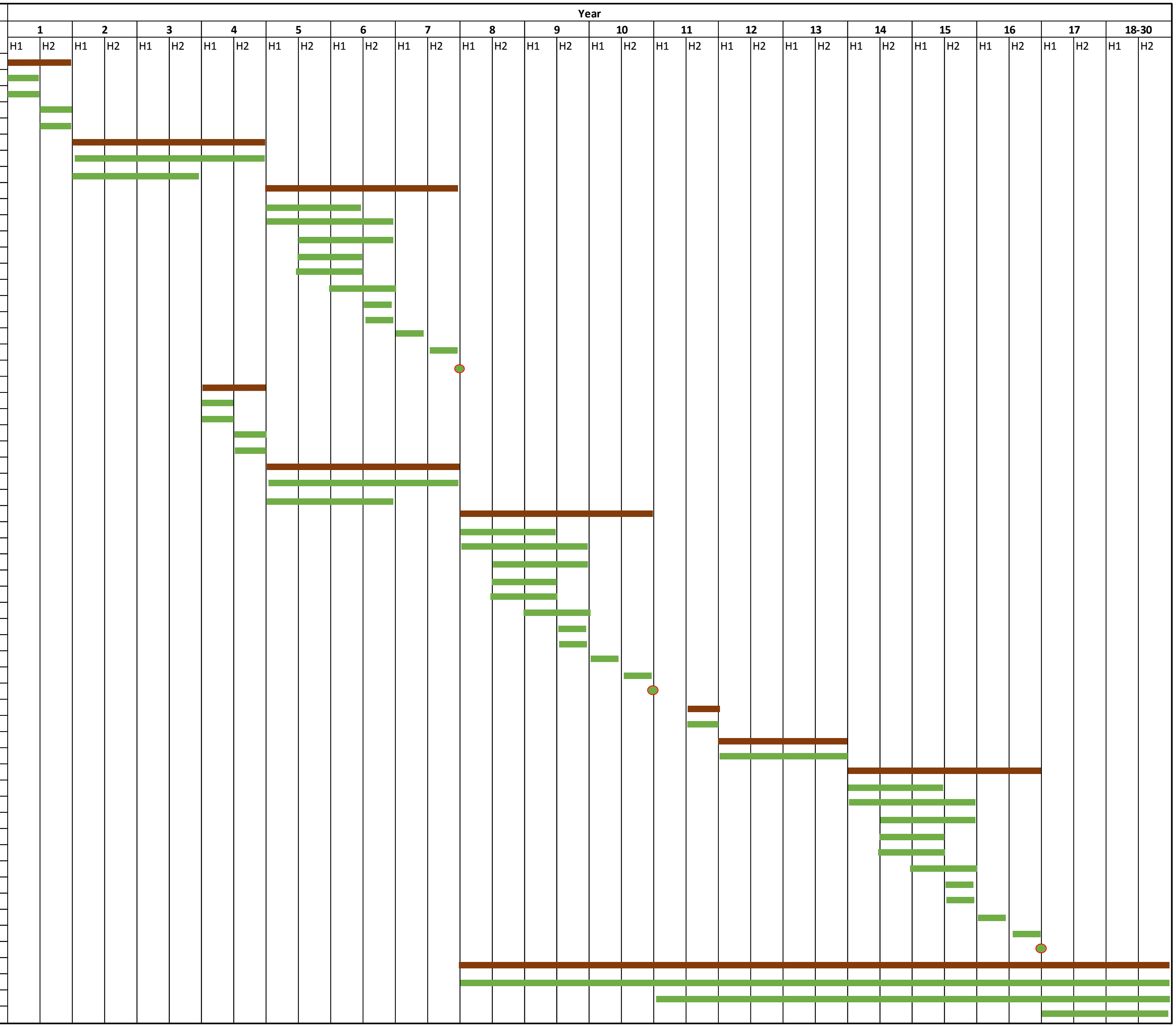
There are three stages in the Project Implementation Phase (See **Table 12-15**Error! Reference source not found.):

In the first stage, the existing landfill sites should be upgraded from poorly engineered dumpsite to sanitary landfill. The upgraded landfill is expected to be the disposal site of the unrecycled bottom ash generated from the incineration process. Also, hazardous waste disposal zones shall be built for the fly ash generated. The proposed site may need to be remediated or cleaned up in order to prepare for the development of the incinerator.

In the second stage, the proposed incinerator should operate for 5-10 years with the capacity of 1,000 tpd to prepare for gradual development of the 1,700 tpd facility in the next stage. The operation period of both stages accumulated would be approximately 20 years.

Table 12-15 Proposed WTE Facility Development Action Plan

Stage	Item
Stage 1: Landfill Restoration	**Tender Phase**
	Submission an unsollicited proposal
	Public Inviatation for competitive offer
	Preparation of Competitive proposals
	Initital proponent to match the lower price
	Permits
	Environmental compliance Certificate
	Local permits (buildings, sanitary, barabgay, ...)
	Construction
	Design
	Site Formation
	Procurement
	Equipment Fabrication
	Shipping and Delivery
	Equipment Structure Installation
	Pipeline Installation
	Electrical Installation Wiring
	Insulation Installation
	Commissioning
	Commeral Operation Date
Stage 2: Incinerator Development: Phase 1	**Tender Phase**
	Submission an unsollicited proposal
	Public Inviatation for competitive offer
	Preparation of Competitive proposals
	Initital proponent to match the lower price
	Permits
	Environmental compliance Certificate
	Local permits (buildings, sanitary, barabgay, ...)
	Construction
	Design
	Site Formation
	Procurement
	Equipment Fabrication
	Shipping and Delivery
	Equipment Structure Installation
	Pipeline Installation
	Electrical Installation Wiring
	Insulation Installation
	Commissioning
	Commeral Operation Date
Stage 3: Incinerator Development: Phase 2	**Tender Phase**
	Contract negotiations
	Permits
	Variations of licenses (Permits)
	Construction
	Design
	Procurement
	Equipment Fabrication
	Shipping and Delivery
	Equipment Structure Installation
	Pipeline Installation
	Electrical Installation Wiring
	Insulation Installation
	Commissioning
	Commeral Operation Date
	Operation
Operation	**Operation**
	Operation of Sanitary Landfill
	Operation of Phase 1
	Operation of Phase 2



13. Review of Current Disposal Site

13.1. Background

The Payatas site combines both a closed controlled dump facility which is receiving ongoing maintenance and a landfill which is being extended as local HHs are resettled.

The following review relates to both aspects of the site.

13.2. Current Status

13.2.1. Cover Material

Provision of cover material was a major issue at the operating face, and applying intermediate cover on areas which have been completed but await expansion and where final cover has been eroded or damaged in other ways.

As discussed during the presentation, cover material serves numerous purposes at the landfill, as follows:

- Cover material significantly reduces the amount of water which can enter the waste and therefore reduces the level of odour generation as well as leachate generation and stability impacts.
- The cover material reduces the ability of land fill gas to escape and therefore obviously reduces the odour generation rate
- The cover material assists with sealing the site thereby making the suction system associated with the landfill gas wells more efficient. Because the odours are obviously associated with land fill gas emissions, cover material will therefore significantly reduce fugitive gas emissions as these will be drawn into the gas wells for scrubbing, combustion and therefore destruction of any odour components.
- Cover material also has the other obvious benefits of reducing windblown litter or eroded waste entering the local drainage system. As noted during the inspection, many drains are partially blocked with litter thereby providing another site for odour generation
- There are also secondary benefits with cover such as reducing the density of animals on the site such as rodents and birds.

Based on the recent inspections, it was estimated at about 5% of the old mound is missing cover material cover in various areas or needs to be remediated.

It is proposed that the existing Mondragon landfill will be extended and this maybe the reason why intermediate cover has not been completely applied. The New Mound was about 40% covered at the time of inspection.

Standard operating procedures at landfills require that any areas which are not to be used for a period of some months should be protected with what is termed intermediate cover which is a 300 millimetre thick layer compared to the 150 mm layer for daily cover and the final cover of 600 mm. The intermediate cover can be recovered just prior to placement of new waste for use as daily cover.

The improvement in cover material application near Filinvest over time has had a major impact on odour and leachate generation and was further improved by the dry weather at the time of inspection.

Even though the current tipping area is tightly constrained and the local batters will be covered with new waste in the future, that does not justify the extensive uncovered areas in the present dumping table and the local batters on the new mound.

13.2.2. Batter Slopes

The external slopes in the current tipping area had been appropriately profiled at the time of inspection. This is an improvement as previously the waste was originally being pushed over the edge of the dumping table atop the new mound, due to a lack of tipping space.

As a result, the waste was sitting at the angle of repose and had the potential to slip. Further the lack of profiling meant the rainwater was not running off and rather will be infiltrating into the waste resulting in odour problems, reduced stability and excess leachate generation.

However as the tipping area has now been expanded as part of the current extension plan, then attention has been given to maintaining appropriate slopes on all external batters.

The Meteor area (south of current dumping area) had suffered a minor slip in early 2014 due to excessive steepness, little or no compaction, no cover and poor toe preparation. This area has received attention in terms of compaction, cover, batter slopes and extending toe keys and now is stable.

13.2.3. Ponded Rainwater

Previously, the active tipping area was not receiving sufficient daily or even weekly cover to prevent most of the rainwater being trapped in exposed waste resulting in odour generation and leachate formation. As noted above, this was predominantly due to the highly constrained nature of the current tipping face.

However it is critical that the current practice of rarely applying cover material to operational areas does not continue now there is sufficient tipping area to operate the dumping table in the traditional manner. This should especially be the case when the new expansion areas are completed, especially the proposed expansion area on the GSIS area If which will yield a large dumping table facilitating correct operational procedures.

Further the active tipping face needs to have at least a 5% slope off so that rainwater will be encouraged to run off rather than infiltrate.

The lack of daily or perhaps even weekly cover has other knock on effects in addition to odour and leachate generation namely trafficability issues following wet weather.

The site was dry at the time of the November inspection but the lack of cover and lack of local 5% slopes will result in both excessive infiltration and also ponding in periods of heavy protracted rain.

13.2.4. Drain Cleaning

All landfills have an issue with litter and eroded wastes entering the drainage system.

However the extent of waste inclusion in the local drainage system is greatly exacerbated by the lack of cover material allowing waste to be blown into the drains or washed into the drains in wet weather events.

The internal drains had been cleaned at the time of inspection.

However the major external local drains are further contaminated by recycling operators merely throwing their non recyclables stright into the local drainage system . Some of these recycling activities occur literary on the banks if not within the drains, and therefore the landfill operators can not be blamed for much of the litter entering the drainage network.

Even in well operated sites, there is the potential for a lot of litter. With the external influences of litter surroundiong and upstream of the site, Payatas is being blamed for all the litter in the creek as it enters Filinvest.

The only solution is to install a “Vee” screen as recommended some years ago. The screen has long wings to allow creek flows to be relatively unaffected as the screen blocks with litter. The screen also floats so as to screen the surface where most litter flows.

The screen will require weekly cleaning by removing from the creek and removing entrapped litter.

13.2.5. Leachate Management

Leachate management was substandard at the site in the wet season, but the impacts of this are somewhat reduced because in the dry weather, the quanity of leachate being generated and exiting the site is substantially reduced over that experienced in protracted wet weather. However there is also a reduction in the diluting flow in local creeks so even small leachate flows remain obvious when exiting the site.

At the time of inspection, there was little leachate exiting the old mound. However there were the number of expression points in the lower batters around the new mound. There were also areas where, because of the incremental changes in the landfill footprint, the leachate is expressing through the gabion rock baskets and directly entering the local drainage system.

Given the plan to yet again extend this landfill into the new development areas at Mondragon and possibly also into GSIS, there is little merit in installing significant permanent works such leachate drains and piping systems immediately. Intercepting leachate flows in the open channels downstream on the rock gabion is acceptable provided that a suitable high flow bypass is installed so the leachate pumping system is not overloaded during rain events.

A better approach may simply be to collect the leachate in dry weather and direct it into the pump wells so leachate can be irrigated over the grass areas or re-injected at the top of the mound. Once the landfill footprint is finally extended, then a permanent leachate drain can be installed near the toe of the final footprintIf to prevent If leachate entering the drainage network whose surface expressions of through the external better. .

The leachate plume entering from the eastern drain at the confluence with the main western drain at the bridge abutment is very obvious. Residents of the neighbouring Filinvest estate could clearly point to the impact of the landfill based on this visual evidence of pollution from Payatas. There are mitigating factors such as discharges from the adjacent piggery but inspection of the landfill site clearly shows numerous leachate expressions around the base of site, either directly through the lower batter but also through broken or missing leachate pipes.

Fresh leachate generally has little odour however if the leachate is allowed to be trapped in various standing water areas or in blocked drains, then the leachate becomes odorous. Most odour in landfills comes from exposed waste that is degrading.

Most of the pumping stations are not equipped with working pumps at the moment and existing pumps have inadequate head capacity in any case, apart from one at the southeastern corner of the site where it is powered by a local three phase generator.

In the original design for the landfill, a series of four pumping stations was proposed and these are still considered necessary.

Furthermore the pumps were to be of the progressive cavity type to ensure that they produced sufficient head to allow the leachate to be pumped to the very top of the landfill in one lift to then enter a distribution mains system. This leachate distribution main system had a series of outlets for allowing connection of flexible pipes drilled with holes to be located around the top of the landfill. The leachate would then trickle down the external batters and evaporate. Recent meetings with the DENR indicated that they would only allow irrigation of the actual landfill proper. This makes providing cover material at the existing Mondragon landfill essential so the leachate can be irrigated in dry weather.

The main leachate pump at Phase four is only operated intermittently for various reasons. Once the leachate pipework system is improved and suitable leachate irrigation pipes are placed, then the pump should be run using automatic level sensors, and not manually as at present.

13.2.6. Waste Compaction

The tipping face was surrounded by a bund at the time of inspection and was being compacted using both dozers on the bund area and the landfill compactor on the flat areas as it should

At previous inspections, waste was being pushed from the dumping table on top of the new mound over the edge of the batter. The waste was sitting at the angle of repose awaiting the final placement, compaction, profiling and cover activities.

As mentioned above, this lack of compaction and profiling maximises rainwater infiltration therefore leading to saturated waste close to the surface resulting in significant odour emissions.

13.2.7. Slope Reduction

The external batter of the landfill near the Mondragon area had an overall slope well in excess of the 1:2.5 as specified in the design at some previous inspections. A cursory measurement of some batters previously indicated that the slope has been increasing recently and the appropriate target of 1V:2.5H should be reinstated in all future developments at the site.

The revised batters near the current tipping area are now back at the desired 1:2.5 slope.

13.2.8. Access Roads and Benches

It is critical that the roads/benches which slope back towards the mound are reprofiled so water flows off the roads/benches and does not get trapped against the batter face. This has been done in most locations.

Also the access road near Filinvest has been reconstructed and covered with soil as required.

13.2.9. Exposed Waste in Completed Areas

In addition to the extensive areas of new waste that remains uncovered, there are still locations where the final cover that has been applied has eroded or otherwise been removed.

Furthermore, there are areas where waste has been deposited on top of the final cover and this needs to be either removed or covered.

These areas of exposed waste are in many locations throughout the entire site and provide not only a source of odour but also leachate generation as well as making the side look untidy overall.

13.2.10. Barangay Singit Batters

This area is obviously closest to the Filinvest complainants. Most of the southerly batter has been covered with soil and recently planted with Vetiver grass.

However the bottom few metres of the southern face remains uncovered. Given that this is the lower part of the site, it is saturated by the normal leachate flows towards the toe of the landfill and therefore odorous.

This area is crucial to the overall odour management at the site and urgent application of additional cover material in the lower sections is essential.

There are also other parts of this batter where the cover material has been severely eroded and needs to be supplemented immediately.

13.2.11. Vertical Drains

These are the drains that run vertically between the benches on the completed batters. These are designed to channel the runoff water collecting on the benches down the batters in a controlled manner to avoid extensive erosion.

Because of the high flow velocities experienced in the steep drains, soil washes out and the garbage below is exposed. This then provides a route for rain water to infiltrate into the underlying waste and for odour to escape.

As specified in the original operations manual, material should be placed in these in the dry season to encourage grass growth and limit infiltration. The operators have explained that sandbags placed in these drains only seemed to last a few weeks as the plastic weave making the bag fabric quickly breaks down. Therefore it is recommended that Geotextile fabric or filter cloth be placed in these drains on top of an underlying soil bed. Vetiver grass could also be planted in holes punched in this Geotextile to provide ongoing stability as well as maximising evapotranspiration in areas that will always attract higher water exposure.

At the recent inspection these drains have been improved but further work is required.

13.2.12. Grass Cutting

POG management advised that the grass needs to be cut to minimise fire risk in the summer season.

While there is some merit to this argument, grass fires should be easy to control on a landfill site where there is a permanently stationed fire truck and ready access to water from the surrounding runoff drains. The recent decision to undertake removal of the cut grass is strongly supported.

A major path for water removal and therefore leachate removal from the landfill mound is through evapotranspiration. By far the biggest component is the transpiration element which is a direct function of the leaf area provided. Therefore by cutting back the grass on a regular basis, the leaf area is reduced and therefore transpiration is not maximised.

Furthermore, the Vetiver grass leaf is very fibrous and takes a long time to fully breakdown. Therefore the cut grass acts as mulch on top of the soil thereby reducing evaporation from the soil surface at the same time that transpiration is reduced.

A better approach is to irrigate in summer so that he grass remains active and not dying back.

13.3. Remediation Requirements

The priority remediation requirements directly reflect the issues listed above.

13.3.1. Cover Application

The primary issue that needs to be addressed is the application of intermediate cover to areas that will not be finalised for some months. A 300 millimetre thick soil layer should be applied to areas such as around the neck area and also the Mondragon sanitary landfill. It is unacceptable to leave these areas fully exposed to the weather and therefore emitting odour, generating leachate and resulting in elevated slippage concerns for such protracted periods. The intermediate cover can be reused just prior to extensions to the existing Mondragon landfill or waste being deposited at the GSIS area extending from the neck area.

Generally the need to cover the site is summarised as:

- the dumping batter below the active tipping face at Meteor/Phase 4
- profile and compact the current dumping area to a minimum 5% slope and start applying daily cover, or at the minimum, weekly cover
- Apply cover material to the remaining small exposed areas on the previously remediated sections of the site, especially on the old mound and also the areas around the neck at the join of the old and new mounds.
- Critically to apply cover material over all previous and potential slip areas to prevent further rain water infiltration and gas emissions. This may need to be undertaken prior to the finalization of the reprofiling, compaction and cover activities on the whole batter.

- To monitor any possible landfill slips at Meteor, install Temporary Bench Marks (Tell Tales) to be able to monitor batter stability.

The required approach has been well documented in the Operations Manual issued as part of the original design, and also practically demonstrated by IPM when implementing the initial remediation work at the site.

13.3.2. Drainage

If in addition to these urgent civil works relating to batters and cover application, the perimeter drains must continue to be cleaned out and reshaped to ensure good flow and no ponding.

The lateral slope issues with the internal benches and access roads must be addressed to remove any ponding. This will be achieved by providing some horizontal fall so the water running down the batter and reaching the bench will then flow along the bench until it reaches a vertical drain, off and therefore will not pond along the bench or internal access road profile.

It is also important that when litter is removed from the internal and external drains, that it is deposited into a truck rather than back on to the adjacent batter. This merely results in the litter drying out and then becoming windblown or simply sliding back into the drain.

The vertical drains must be sealed to prevent ongoing infiltration and subsequent odour emission. If the current practice of sandbagging is not working because of degradation of the plastic bag, then a geotextile or filter fabric should be used after placing a layer of soil in the base and walls of the drain to seal the site.

There were two areas of collapsed gabions near Filinvest which require repair before any further slips occur on the slope.

13.3.3. General Odour Management Issues

The height of the waste mound compared with the surrounding residential area means that an odour plume can move by what is termed down valley drainage from the waste site onto the neighbouring properties. This will mostly occur during periods of stable atmospheric conditions such as cool mornings. Apart from reducing the amount of odour generated at the site, the only other way to minimise the impact of this down valley drainage is to provide a physical blockage between the sides and the neighbours. This could best be achieved by retaining the hill between the new mound and the Filinvest subdivision.

As advised previously, it is also strongly recommended that as many trees and other tall plants such as bamboo are planned around the periphery of the site. This introduces a roughness element into the down valley drainage flows as well as normal odour migration due to winds. This roughness element causes turbulence which will entrain clean air into the odorous plume and therefore dilute the odour concentrations as the plume exits the site.

In general, planting of small shrubs and trees around any part of the site is highly recommended. In addition to providing some roughness element for odour dispersion, the trees also help to remove leachate through transpiration as well as hiding the landfill site from the neighbours' view.

Larger trees, particularly those with a main tap root, will penetrate the 600 millimetre thick final cover. Once the tree roots enter into the waste proper, the anaerobic conditions can cause tree die off. Therefore if large trees are to be planted, or any other tree with a deep root system, then the thickness of the final cover should be increased at the location of the proposed planting.

However by far the most important issue is applying the correct thickness of cover as:

- Daily/intermediate cover to prevent water infiltration and thereby keep waste as dry as possible – drier waste means less odour

- Intermediate/final cover to limit odour emissions

13.4. Leachate Irrigation and Reinjection

13.4.1. Background

The DENR have instructed that leachate cannot be reinjected because of concerns about polluting the groundwater table and ultimately the La Mesa Storage.

The University of the Philippines study, which included the establishment of a series of groundwater wells and also groundwater monitoring, entitled “Payatas Dumpsite -Novaliches Reservoir Groundwater Contaminant Transport Simulation Studies” concluded “From the sampling, there is no sign of groundwater contamination towards the La Mesa reservoir.” Furthermore an examination of the relevant levels of the leachate contained within the landfill mounds and the La Mesa storage level indicates that such a flow would be extremely unlikely, supporting the results of the very detailed University of Philippines study.

Regarding the general concern about the reinjection of effluent, the World Bank current guidelines on landfilling in developing countries strongly endorses the concept of reinjection and irrigation rather than treatment and discharge of leachate. The main reason being the higher capital and operating costs associated with leachate treatment plants almost always results in the plant being bypassed and leachate being discharged untreated into the receiving water environment.

In general, regarding the likely movement of leachate from under the landfill to neighboring areas, the Environmental Management Plan prepared for the site recommended that a series of four groundwater wells be established around the site perimeter. This would then allow IPM to absolutely demonstrate that there was no impact on the local groundwater and therefore ongoing reinjection should be allowed.

However if the DENR are now in a position where they cannot support reinjection for political reasons, then perhaps it could be just termed “subsurface irrigation” meaning that the leachate will be injected just underneath the final cover to allow the grasses and vegetation to access this leachate in the upper areas of the waste mound, and to then remove the liquid through evapotranspiration processes.

Installing the perimeter groundwater monitoring wells and sampling the groundwater to confirm no groundwater contamination was occurring as a result of the landfill would also the support the argument that the irrigation of previously worked areas outside the three hectare sanitary landfill should be supported. In any case, the irrigation application rates would be matched to the day to day evapo-transpiration rates, such that there would be absolutely minimal (if any) deep drainage of leachate through the final cover into the waste below.

Furthermore the leachate would be irrigated towards the top of the mound where the waste underneath was unsaturated. Therefore any leachate infiltrating through the final cover into the waste will be generally absorbed by the unsaturated waste in the upper levels of the mound and not percolate down to meet the saturated zones at the base of the landfill some 30 to 40 metres below.

In summary, the DENR decision to disallow reinjection and only allow irrigation on the three hectares sanitary landfill, and future landfill areas, is disappointing. The above arguments may be helpful in trying to get DENR to review their decision. In any case, it could always be argued that the grass and vegetation was suffering heat stress and desiccation in dry periods and therefore had to be sprayed with leachate to encourage vegetation survival.

13.4.2. Leachate

The leachate interception drainage system should be surveyed to ensure that all breaks are repaired and any blockage is removed. This may be part of the Infrastructure package of the current tender. If the leachate drains are suffering from biofouling inside the drain, it should be cleaned by inserting a high pressure hose from either end to remove this material. Alternatively a chemical bleach can be added or something such as caustic soda to kill off the biofouling. However it will be critical if such chemicals are applied that the leachate is retained and reinjected and not discharged or irrigated onto the grass.

The existing pumps remain inadequate. All pump station should be equipped with either a progressive cavity pump or a multi stage submersible centrifugal pump. The pumps will need to generate at least 50 metres head to ensure that the leachate can be lifted in one step to reach the top of the landfill.

The proper 3-Phase pumps are float controlled meaning that operator intervention is not required as at present. The pump is left switched on but will not start until the leachate fills the leachate pump station to the desired level as set by the level of the top float. Once the float is lifted by the leachate, the pump starts and will run continuously until the level of the leachate drops to the level of the lower float. When the leachate drops to this lower float level, the pump stops running and will not start again until the leachate fills the pump station again to the level of the top float. This is standard at pumping stations globally.

These pumps can start up to 10 times an hour without damage and will only do so in periods of high leachate flow. In low flow periods, the pump may only start once a day. In many well run landfills, the leachate pumps only run 5 or 10 minutes a day.

Correct settings on the floats means that even high capacity pumps required for the wet periods will not be damaged in drier periods.

All these pumps come equipped with an internal cut-off control so that if the bottom float fails for some reason, and does not switch off the pump, then the pump will still shut down before it becomes damaged.

Most pump stations also have an “emergency or alarm” third float set at the highest level which switches on an alarm or flashing light if the pump fails or the leachate level gets too high for whatever reason, such as pump blockage.

The actual levels for the 3 floats are a matter of trial and error to some degree but generally the following should be the initial levels used:

- The pump stop float (bottom float) is set as low as possible but just above the level where the pump starts to suck air or cavitate
- The pump start float (middle one) is set at the desired maximum level in the pumping station.
- The alarm float (top one) is set above the pump start float to indicate pump failure

Lengths of 75mm diameter HDPE pipe with holes drilled every 300 mm are then required for irrigation of the leachate. Again this combination of pumps and irrigation outlet pipes is exactly what was specified in the original design and remains essential.

The current main leachate pump is powered by a diesel generator. Considerations should be given to running three phase power from the Pangea generators to the main pump stations and could also be used for local security lighting. An electrical engineer would have to determine the size of the three phase power line required to ensure that the voltage drop was not excessive thereby causing electrical stress on the pump. The initial attempts at running power were inadequate is only 2 to 3 mm conductors were used and significant voltage drops resulted leading to damage to the pump electrics. The cost of running three phase power will be significant and should only be considered if IPM is considering tendering for a landfill operations contract extension beyond December 2015.

Negotiations may be required with DENR to allow irrigation on areas other than the formal sanitary landfill. Some possible justifications for extended periods of irrigation and also reinjection are provided later in this report.

13.4.3. Essential Works Required

The essential works required are summarised below as well.

However it is accepted that the infrastructure tender under preparation at the time of inspection will, if successful, provide most of the infrastructure items required to significantly improve the site operation. These items would include those listed above, such as upgraded leachate drainage systems, leachate pumping stations and pump sets as well as delivery mains to allow the leachate to be transferred to the sites required, such as the proposed leachate treatment plant or to areas to be irrigated or reinjected.

- Repair all damaged leachate drains even if just as a temporary measure awaiting landfill footprint expansion. These repairs may be in terms of temporary HDPE piping or maybe in terms of interception trenches placed downstream of the gabions. These drains would be sized such as to deliver dry weather leachate flows into a suitable leachate pump station, but have an overflow weir such that during wet weather when elevated flows occur in the drains, the diluted leachate is allowed to discharge from site through the main drainage canals.
- Install suitable high lift capacity pumps as described in the original design document. A total head capacity well in excess of 50 metres will be required.
- Install suitable HDPE piping from the pumps to the top of the mounds.
- Install a number of movable HDPE pipes which have holes drilled approximately every half metre along their length. These pipes would be relocated on a daily basis to different parts of the mounds and at different levels to achieve good irrigation of the entire site. This will be particularly beneficial in the dry summer when the vegetation dies back and could present a fire risk.
- In the event of protracted wet weather, the irrigation system should cease and leachate be reinjected to the top of the mounds, using reinjection wells as shown in the original design documents, or a portion of the stream be directed to the leachate treatment plant.
- A staff member should be dedicated to monitoring the leachate irrigation and reinjection systems to ensure they operate effectively and that the irrigation pipes are moved as required
- It should also be noted that if the leachate can still be irrigated during the wet season. Maximum evapotranspiration will be achieved when the cover soil at the site is close to saturation, so on-going irrigation even in the wet season is required. The aim is to maximize evapotranspiration and not just irrigate sufficient leachate to support grass growth.

13.5. Landfill Stability and Safety

13.5.1. Introduction

Earthquakes or extended saturation depths within the waste mound can make landfills fail if the slope is too steep, such as the near vertical slopes that failed in the 2001 wet season at Payatas, or if there is an inherent slip line within the waste mound along a sloping artificial liner.

Therefore the proposed remediation is essentially to reduce the slope to a grade of 1:2.5 or about 22 degrees. Over time the waste settles (up to 25%) and the slope gradually flattens to 1:3. Domestic mixed waste is generally stable at a 1:1 slope, but this slope is reduced to allow the soil to stay on the slope and to facilitate access. Because of these non-structural requirements to have flatter slopes, an even safer design with flatter slopes therefore results.

Waste mounds are generally saturated in the lower third or so, and this leachate level varies throughout the dry and wet seasons. Having waste mounds in a wet climate does not inherently make them unsafe. Landfills with the usual 1:3 final batter slopes are stable in very wet areas such as Ayr and Home Hill in Australia which receive over 4,000mm of rainfall a year.

Earthquake induced failures or general slope failures at well operated and designed landfills are usually along a liner face. The most common failure is when the waste moves as a mass sliding along the artificial liner such as HDPE placed on a slope. Payatas has an essentially flat base of natural soil and therefore no potential for a mass slip failure event along a sloping artificial liner face.

In terms of doing a failure analysis on the landfill, a sensible slip circle failure analysis is very difficult as the garbage is not homogenous or even isotropic given the load compression that results with depth and the waste placement method. The other key issue is that the unsorted garbage at Payatas includes large items such as sticks, lumber, long sheets of plastic, metal and concrete objects, etc. The necessary random placement of these larger items greatly limits the chance of major slip circle failures by providing a series of independent strong links that extend across and through potential slip circle planes.

In summary, these random objects interrupt the opportunity for a large sector of garbage to slip along a traditional circle in a stable-sloped design.

Landfills are being built all round the world in worse (wetter) weather conditions in earthquake affected areas without problems at this slope. The 1:3 final slope is included in many international guidelines and criteria.

Another practical response is that if new design slopes are unstable, then the original steep slopes at Singit did not collapse regularly. These slopes are very much steeper than the new slopes being constructed at Payatas at present.

Further the existing steeper slope just north of the Neck on the Mondragon side has a slope exceeding 30% which is 25% steeper than the design slope. This batter has been stable for over a decade and awaits the extension of the Mondragon Landfill to be incorporated into new waste and the slope internalised.

The only failure type that would be expected could be small localised slips of the cover material prior to the grass roots being sufficiently established in the first growing season. However the underlying waste is not expected to move.

Even if there was a major slip, it would be stopped by the surrounding perimeter road and drain/creek easement width and then the creek batter itself.

International landfill failures are due to one or more of the following elements, none of which are part of the standard Payatas remediation;

- poor waste placement and compaction,
- uncontrolled waste acceptance, such as liquid waste being allowed into the waste mound
- poorly sited waste mounds on unstable (low bearing capacity) subgrade
- incorrect slopes (>1:2.5 settling to a final 1:3 over time),
- poorly located or steeply sloping artificial liners without benching (Benches have been included at Mondragon), and

- large voids in the waste mound that can fill with landfill gas and explode

13.5.2. Payatas Sanitary Landfill - Facility Verification Initiative

The August 2013 “Payatas Sanitary landfill Facility Verification Initiative” notes geological strength issues with some localised weak clay bands to a depth of 7 metres and counsels against deep excavations near the landfill toe.

Perimeter excavations have been predominantly in very stable conglomerates and there are no signs of geological based failures.

The proposed future excavations relate to perimeter drainage works (remote from the landfill toe due to perimeter access road requirements and are relatively shallow generally) which are into essentially conglomerates or soft rock substrate, or minor local drains which are shallow.

Therefore the local geology is not considered a risk to landfill stability based on present development models.

13.5.3. Stability against Earthquakes

Various papers and work such as those listed below have addressed the stability of landfills under earthquake action. These include:

- Anchor Environmental Aspect Consulting on the “Remedial Investigation/Feasibility Study, Holly Street Landfill Redevelopment Project, Draft Final,” November 2001;
- “A New MSW Landfill Well Below Groundwater In A Highly Seismic Region” by R. J. Dunn and A. De, Proceedings Sardinia 2003, Ninth International Waste Management;
- “Performance of Solid Waste Landfills in Earthquakes” by N Matasovic, E Kavazanjian and R L. Anderson, Landfill Symposium S. Margherita di Pula, Cagliari, Italy, 2003; and
- “Performance of landfills under seismic loading” by Anderson, D. G. and Kavazanjian, E. Jr., 1995, Proc. 3rd International Conference on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics, St. Louis, Missouri.

Overall it is concluded that a landfill with the proposed 1:2.5 side slopes would be stable for earthquakes up to 6.7 magnitude.

Landfill “forensic” analysis, the examination of landfill durability following seismic events, has taken root in the last two decades, following California's San Fernando, Loma Prieta and Northridge earthquakes. Although complex in some respects, the emerging research can aid design engineers, geomembrane manufacturers and government regulators in estimating landfill slope stability under static (normal) and seismic conditions.

Earthquakes pose a number of threats to landfills, including the potential for tom liners and covers as well as leachate and gas leaks. Recognizing the geographic scope of risk, the US Environmental Protection Agency (EPA), under Subtitle D, requires designers of all municipal landfills to consider earthquake issues. Since then, landfill-related research has grown, but the 1994 Northridge earthquake (6.7 magnitude) gave engineers their first opportunity to survey post-quake landfills built to Subtitle D standards.

A team of experts from Berkeley examined 22 landfills within 70 kilometres of the Northridge epicentre. None of the locations sustained major damage as a result of the earthquake, and, of the seven Subtitle D sites, minor damage was discovered at only one.

At Chiquita Canyon Landfill, 25 kilometres from the epicentre, engineers found a 5 metre tear in a geomembrane located above the waste line. Subsequent investigations by the owner’s representative indicated that the tear was caused by landfill operations prior to the earthquake and was not attributable to earthquake ground motions.

Closer to the epicentre, Lopez Canyon Landfill remained intact, sustaining no damage to its bottom composite liner or the 1:1 side slopes containing geomembrane and geosynthetic clay liner. No evidence of either transient or permanent displacement between the interred waste and liner system was noted.

Until a more complete database of Subtitle D landfills is accumulated, the USEPA urge designers to be conservative in planning landfills in seismic impact zones. They expect that liners should perform to specification with a 100 metre high waste mass under a peak ground acceleration of 0.69 gravity pull (g) during a 6.5-magnitude earthquake.

The key parameter to slope stability (both static and seismic) is interface strength where geomembranes, geogrids, textiles and clay liners lie against one another.

Interface strength is site-specific depending on the applied normal stress and the water content, density, chemical resistance and texture of the various layers. Other slope stability parameters concern the steepness of the slope, the height of the waste mass, pore pressures in the soil and waste, local loading conditions and the potential for settlement.

Historically, the effects of peak acceleration on landfills have not been easily sampled and quantified. In an effort to gather more precise seismic data, a few landfills in California are being equipped for exact measurements during an earthquake.

In summary, the greatest risk is where liners overlap providing a shear surface for movement.

The proposed landfill only has a single liner, not a double or triple liner configuration, and the sides are at the 1:2.5 slope recommended, so it is considered that the landfill design will be stable under all but the most extreme earthquake. The local seismic hazard maps are being examined to assess exact details but in other earthquake prone countries such as Pakistan, their data shows a 10% probability in 50years of 1.6 to 3.2m/s^2 accelerations. The USEPA interim guideline is 0.69g or 6.5m/s^2 so the landfill design easily complies.

The report entitled “The response to the finding of the mines and geosciences bureau and a resolution of the multipart site monitoring team of the Quezon City landfill facility” notes that the earthquake hazard for the site is a PGA of 0.62 G resulting from an earthquake magnitude of 7.4 on the west valley fault at a distance of one kilometre from the site.

This acceleration figure is less than the U.S. EPA limit of 0.69 G and therefore Payatas could be considered safe even with an earthquake of 7.4 magnitude occurring locally.

The recorded earthquakes in Manila rarely exceed 6.5 and in such cases, the general civil damage is so widespread that any small slips in a landfill are insignificant in a disaster context. Previous earthquakes have not resulted in any major slips.

13.5.4. Maximum Possible Height of Landfill

Currently the maximum height of wastes at high at Payatas is approximately 45 metres.

Internationally landfills have waste to a height of 90 metres and are stable.

At Payatas, there have been a number of localised slips and the reasons for these are very consistent and avoidable, and may be summarised as follows:

- Waste was not being compacted
- Waste was not being covered and thereby allowing rainwater infiltration
- Waste surfaces were not profiled so that rainwater would have infiltrated rather than running off
- Leachate was not being withdrawn in a controlled manner
- External batters were not being trimmed to the desirable slope and in fact the entire batter was at the angle of repose

- Insufficient or no ‘key” placed at the toe of the batter. Especially where waste is placed on an artificial liner, a substantive earthen bund or gabion must be provided which is keyed into the local natural soil.

With the current and ongoing operation, most of these issues have been addressed and appropriate operational procedures implemented.

Where the site has been operated in a controlled manner, there have been no major slips even though there have been extensive typhoon impacts and also some earthquakes.

In fact in three different locations the slope still significantly exceeds the desirable 1vertical to 2 ½ horizontal target. These areas are located just to the north of the neck area on the eastern side, one or two small areas in Singit and finally near Scandinavia. In most cases these profiles will be covered with waste in the future and have not been levelled to the target slope because of their ongoing stability over the last decade.

The only significant slip in the last decade has been near the neck area close to GSIS. This was following extensive rain and also a period where cover material application and compaction was substandard. This inattention to detail was audited and inspected, and a site engineer responsible counselled. Since then, there have been no other collapses or major slips resulting in significant blockage to the local drainage network, let alone the movement of waste beyond the site perimeter.

The best test of slope stability is monitoring the reality of the installation, rather than comparing slopes and other indicators against theoretical targets. Based on this, Payatas remains completely stable even where some of the slopes are greater than desired and cover material has not been applied for waiting for an approved extension. For this reason and based on extensive international experience, it is safe to raise the height further as per the original design completed in 2003.

13.6. Future Capacity

13.6.1. Introduction

The estimated lifespan of the landfill sites are summarized in **Table 13-1.** There are two main areas for expansion, namely Mondragon and GSIS. GSIS has two possible distinct development phases but significant agreements are yet to be reached between the operator and QC before these expansions could proceed. Further, DENR approval would be required.

There is also the opportunity to further raise the height of both mounds in accordance with the original development plans, as well as overtop the neck area between the two mounds.

13.6.2. Incoming Loads

The on-going and increasing success of the MRF and RDF activities means that there is only 1140 tonnes per day of residual waste requiring disposal, based on the detailed analysis in the August 2013 “Payatas Sanitary landfill Facility Verification Initiative”. This report has unusual values for some parameters such as bulk density of 0.21t/m^3. This is less than normal for domestic waste which ranges from 0.25 to 0.33 t/m^3 generally. Other data assumptions are also unusual for the waste type being sent to Payatas but overall the final estimate of cubic metres per day is not greatly different to the estimates used below.

It should be noted however there remains a paucity of accurate information on how many tonnes per day are actually entering the landfill. Whilst estimates based on truck volumes and appropriate densities are indicative, the only real way of determining the landfill load and therefore the life of extension areas is by determining the actual mass of waste coming in per day on average. Given that there are no permanent weighing stations installed at Payatas, temporary weigh scales should be utilised over a period of some weeks to determine the average tonnage entering the site per day as well as the tonnage of recyclables leaving the side.

The landfill compactor on site can achieve waste densities of up to 900 kg per cubic metre but the conservative density assumption would be 800 kg per cubic metre. This means that approximately 1420 cubic metres of waste will be placed daily.

Cover material usually makes up 15 to 25% of the total landfill airspace. However the likely application of weekly cover rather than the daily cover means that this quantity would probably reduce to closer to 5 to 10%.

This gives a total daily airspace consumption of 1500 cubic metres.

Given the short timetable of these investigations, there is no need to allow for increases in population and waste generation given the high error bands associated with the load estimates as the base. In many Waste Management studies, the amount of waste going to landfill is often assumed to be static over the short term of a few years because as the population increases so does the increase in greater recycling effort both at home and during the transfer and disposal process. Locally this may be increased RDF or composting/bio-methanation initiatives being implemented for example.

These two effects basically cancel one another out indicating that the total mass of waste going to landfill at most locations in the very short term does not increase over time.

13.6.3. Mondragon Development Staging

The initial plan is to continue expansion of the landfill footprint into the Mondragon area while GSIS is prepared in terms of final relocations.

In the immediate term, an area of 4800 m² is cleared ready for development. Much of this area is located on virgin soil and will be excavated to a depth of approximately 5 m to obtain cover material as well as maximize the space available.

In addition to this one half hectare, there are also some small additional areas in the lower lying parts of the expansion area that can accept waste. However these areas are not located in a spatially efficient format in terms of landfill space maximisation, and should be retained as contingencies to allow stockpiling and equipment parking for the time being. These areas would sensibly integrate with the longer-term expansion areas to provide a sensible footprint shape.

As this half hectare area is being developed and possibly other portions at GSIS, then the relocation program can continue within the remainder of the Mondragon area such that the final perimeter drain relocation along the danger zone boundary can occur.

The final area will be developed up to what is called the “danger zone” which is essentially a straight line on the limit of the site that is currently politically acceptable to use for landfilling. This area is also located in virgin soil that will be excavated to a depth of five metres as well.

Because of the depth of excavation required at some of the higher elevation points, it is impractical to install a perimeter open drain. Rather a RCP 1500 millimetre diameter pipe will be installed and then covered. The suitability of this option is discussed in a later section but it is considered appropriate for the development phasing. This will avoid the inclusion of any tight or even 90 degree bends in the creek and also yield a significantly reduced flow length. Therefore the hydraulic impact of the final drain relocation will be positive in terms of reduced friction losses along the reduced drain length and the resulting ability to more quickly remove any flood waters, as well as reduce the amount of erosion occurring at sharp bends in the creek.

Once the final creek relocation occurs, then the entire Mondragon area can be developed as landfill in an efficient manner.

13.6.4. Mondragon Airspace

The initial extension areas described above translates into a relatively efficient development as the expansion area mates well with the shape of the existing landfill mound.

The volume available from filling this area will provide 0.3 years of operation. This is less than was provided by the two smaller areas previously developed in Mondragon because of reduced doubling affect associated with the infill onto existing mounds. It does however involve some increase in height of the neck area but only by 5 m on average.

13.6.5. GSIS

The triangular area is available for almost immediate waste disposal.

There are three different projected areas associated with the GSIS expansion in terms of overlying on the existing mounds.

The direct overlay volume associated with the approximately 6000 square metre base area assuming a 40 metre lift before any over-topping on the neck area will result in a 240,000 cubic metre air space increase.

The further 40,000 cubic metres of aerospace is achieved by the projecting this base area against the northern curved area of the neck.

Some 60,000 cubic metres of additional airspace is achieved by projecting the base area against the curved area of the new mound.

Once these three additional areas are developed, there will be an opportunity to raise the lowest point of the neck area some 10 metres in elevation. This will provide an additional 50,000 cubic metres of air space. This is less than the volume calculated in March as waste is already being deposited over the neck area as part of ongoing development.

The total airspace therefor achieved by utilising the triangular area already essentially vacated in GSIS is therefore approximately 390,000 cubic metres of airspace.

Based on the adopted 1250 cubic metres of aerospace consumed per day, this would provide an additional 0.8 years of operation as a minimum.

13.6.6. Longer Term Site Capacity

Mondragon Overall

The ultimate expansion footprint in the Mondragon area is going to have a linear edge to allow a suitably straightened course for the creek, as required by the hydraulic engineer's calculations. The total expansion area within this footprint is approximately three and a half hectares.

Because it extends the foot print around the current neck area between the old and the new mounds, the present saddle effect on height constraints in the neck area will be overcome. Therefore the waste in the expanded area contiguous to the next will also be able to reach at least a 40 metre height. In fact the entire three hectare expansion could go a further 10 metres higher making a total expansion up to 50 metres high if required.

Based on a three hectare expansion area and a 40 metre height, the total air space would be 1.2 million cubic metres. However a perimeter bund and local drainage system is required to assess that adding it 10 metres set back from the so-called "danger zone" to that of the landfill. This reduces the total airspace to 1.03 million cubic metres, excluding the volume associated with the initial development.

The residual waste volume for disposal is not expected to increase in the near future. Whilst community incomes will increase and therefore the waste generation rate increase as well, most of this volume increase will be packaging materials which are readily recyclable. It is assumed that the increase recycling and recovery activities will directly compensate for any overall increase in gross waste production. Therefore it is expected that the daily air space consumption will remain at 1,250 cubic metres a day.

This gives a life for the next expansion to the so-called “danger zone” line of about 1.8 years, assuming no GSIS development and maximising the height at the neck area.

As a rule of thumb, for every 10 m that the foot print can be extended into the so-called “danger zone” near Mondragon, a further four months of landfill operation is available.

GSIS Overall

There is also the possibility of utilising remaining part of the original GSIS expansion. This provides an area of at least two hectares but excludes the recently purchased land in three blocks by IPM as well as the Quezon City holdings. There are a number of other blocks that will have to be obtained and cleared before the GSIS area could be further expanded beyond the notional two hectares currently targeted.

Given that the constraints in the neck area will be removed due to the expansion associated with the Mondragon landfill development, the GSIS area could readily achieve an elevation of 40 metres. This gives a total volume of 810,000 cubic metres, or some 1.8 more years.

The initial triangular expansion in GSIS will provide 0.8 year’s operation, therefore the full GSIS area development will provide a further one year’s capacity.

Neck over-topping

Once both the GSIS and Mondragon landfill expansions are completed, it would then be possible to raise the entire expansion and neck area a further 10 metres. This increase in 10 metres would apply to the five hectares of expansion area in GSIS and Mondragon as well as the neck area of two hectares. This then could provide some 390,000 cubic metres of airspace, allowing for the airspace already can share in by current development along the neck.

This additional airspace just associated with over-topping would therefore be a further 0.9 year’s capacity.

13.6.7. Ultimate Capacity

With this expanded footprint area for the entire landfill, the total height could be further increased at all mounds by a further 20 metres or more and not violate any safety or stability issues. However the new mound has already been raised by 6 m over part of its plateau top since the March calculations were undertaken.

This would add more than 1.2 year’s additional life of the site without requiring the expansion of the footprint area.

Any further expansion into the GSIS or a generic Mondragon area would add even more life to this existing decade airspace. At the time of writing this report, additional areas within both the GSIS and Mondragon area were the subject of contractual discussions with the land holders and government.

There is also the possibility of buying additional land along the Visayas alignment. However the initial triangular portion has the greatest width at the northern end which will not provide significant additional airspace to the landfill as this is close to the northern toe of the site. This triangle tapers towards the Pangea facility.

Table 13-1 Estimated lifespan of landfill

Area	Life (years)
Initial Mondragon area	0.3
Initial GSIS area (Triangle)	0.8
Remaining Mondragon footprint	1.8
Remaining GSIS footprint	1.0
Overtopping of combined GSIS and Mondragon plus neck area	0.9
Raising both mounds 20 metres	1.2
Total	**6.0**

13.6.8. Alternative Site Development Options

At present the POG is developing a Post Closure Plan which considers placing Manila Seedlings and other co-locators on top of the old mound, such as landscaping companies.

These facilities would use the compost from the proposed compost/bio-methanation plant to be located at GSIS.

In reality the compost/bio-methanation plant could be located on top of either mound, and GSIS area used for waste placement so-called “danger zone”

14. Management of Specific Waste Types

Management of the waste entering the site will be critical for both environmental and personnel safety.

The presence of medical waste observed during the audit confirmed that management of incoming waste needs improvement and the following details set out a possible approach, to be refined during project implementation.

14.1. Summary of Waste Categories

The waste entering the Site may be categorised as follows, with some examples given;

- Acceptable Wastes (General) – general household and commercial waste;
- Acceptable Wastes (but Difficult) – tyres, mattresses;
- Special Wastes (Sometimes Acceptable) – asbestos, liquid waste;
- Prohibited Wastes – radioactive waste.

The first two categories are always accepted, but the second category requires some special management. The third category may be acceptable based on quantities involved, actual waste characteristics and so on, and is decided on a case by case basis. Prohibited wastes are never allowed into the Site.

It is critical that all loads are inspected when they arrive at the Site gate or any future transfer station in the collection system.

14.2. Acceptable Wastes (General)

The following general wastes will be accepted at the Site;

- domestic solid waste, as collected by city or private vehicles on a regular basis;
- acceptable commercial and industrial waste regularly collected by contractors;
- garden waste (i.e. green waste or yard waste) that may or may not be collected separately to municipal waste;
- inert waste, i.e. construction and demolition debris including concrete, timber, masonry, bricks, etc. These should be stored separately as they can be reused for gas collection blankets, etc.

14.3. Difficult Wastes (but always Acceptable)

Difficult wastes are those wastes that are allowed to be tipped at the Site, but require special treatment to ensure that the best compaction/disposal is achieved. This class does not include hazardous or dangerous wastes. See **Appendix J – Difficult Waste for details**.

- Tyres;
- Mattresses;
- Whitegoods (fridges, freezers or stoves);
- Car bodies;
- Drums.

14.4. Special Wastes (sometimes Acceptable)

These are other wastes that may be accepted on Site, but will have to be decided on a case-by-case basis, and would include some hazardous and dangerous waste. More details will be provided on how to manage these materials during project implementation, such as;

- Asbestos;
- medical waste, including "sharps";
- dead animals;
- pathogenic wastes;
- “dry” sludges, such as treatment plant sludges;
- low level radioactive waste;
- liquid waste, including paints and thinners;
- toxic substances, such as acids and biocides (pesticides and herbicides); and
- contaminated soil.

See **Appendix K – Special Wastes** for details.

14.5. Prohibited Wastes

Items always unacceptable in the Site will include:

- hot loads, greater than 50°C in temperature;
- pressure cylinders e.g. Condemned gas cylinders, fire extinguishers;
- recyclables, except to the recycling area, such as greenwaste, bulk metals or reusable demolition waste;
- large volumes of liquid waste;
- radioactive waste;
- large containers which cannot be crushed; and
- dangerous goods, such as reactive chemicals, explosives including unexploded bombs and so on. Dangerous goods are those wastes that can affect a person’s health or the environment. Some wastes appear to be safe when delivered to the Site but when tipped can react with the air, water or other wastes to form a dangerous material. Typical dangerous goods include***;***
  - Chemical wastes which can react to form dangerous gasses, liquids or solids. Chemical wastes can be either liquid or solid.
  - Radioactive wastes. These can come from hospitals, universities, research institutes and private companies.
  - Liquid wastes can be dangerous. These include oils, pesticides, solvents, paints, etc.
  - Asbestos (can be safe if correctly packaged, but dangerous if dry and powdery).
  - Medical waste (may be safe if autoclaved or pre-treated in some other manner, but very dangerous if containing untreated used sharps and syringes).

There are many dangerous goods that can be delivered to a Site, and Site staff must be trained to exercise extreme caution when dealing with these wastes. An Operations Manual will need to be developed prior to operating the new landfill.

14.6. Pathogenic and Medical Waste

This material represents a very small part of the total waste stream, but is particularly dangerous to workers and scavengers. Therefore it needs to be addressed in detail during project implementation.

Local hospitals have incinerators and reportedly have a waste segregation policy in place. The infectious material includes general domestic waste which has come in contact with infectious material such as cleaning equipment, as well as sharps. The simple, but effective segregation procedure should ensure that the most dangerous components, namely the sharps and infectious material, are sent to the incinerator on site rather than mixed with the domestic waste. This reported segregation activity has not been confirmed, but will be reviewed during the next stage of the project implementation.

Incinerators at the hospitals are reportedly not fully functional and the World Bank is attempting to assist the hospitals in upgrading these items. This will be reviewed during project implementation.

Various local small medical facilities, such as medical clinics, have inadequate facilities to correctly handle all their special waste. This has been confirmed by some medical wastes appearing in the waste dump locally.

The main issue of concern is sharps (needles, scalpels). Assuming that incineration is not available, these should be managed by either:

- placing in a puncture proof container, disinfected and co-disposed with waste in a dedicated cell at the Site, or
- destroying by burning in dedicated cardboard boxes fuelled by petrol or in special desk-top electric incinerators, for example. This is usually done at the Site of waste generation.

The key issue is that all medical facilities must segregate their waste at source prior to collection. That will ensure that only small quantities of the dangerous wastes are generated for special handling.

- Red bag for infectious waste,
- Black bag for general waste, and
- Yellow puncture proof containers for sharps
- Sometimes Orange for radioactive waste

The ultimate solution is to require medical waste incinerators at the various institutions. Ash residual could be safely co-disposed with the general waste at the landfill. The general requirements for a mediwaste incinerator are that the temperature should be over 1 200^{o} Celsius and have a residence time of 2 seconds. However, the cost would be prohibitive for small facilities.

Due to local cost constraints, a dedicated disposal area at the Site for pre-treated medical and other special wastes will need to be considered at this stage. An alternative is autoclaving the hospital waste either at source or centrally at the ISWM site.

In summary, infectious waste should be disinfected at the hospital or medical clinic and then deposited in a dedicated location within the landfill cell, along with household and other hazardous waste.

More options will be developed and refined for managing these wastes. The exceptions are the larger hospitals which have their own waste incinerators and adequate segregation procedures in place.

14.7. Household Hazardous Waste

The waste inspections identified only a very small quantity of household hazardous waste in the waste streams, such as used fluorescent tubes. Following the Information and Education Campaign and possible implementation of basic waste segregation, all household hazardous waste should be deposited in a dedicated cell within the landfill.

This dedicated portion of the cell would also be used to accept other appropriate hazardous waste. The cell would usually have an operational life of only six months before it is then covered with clay soil, and an adjacent clay trench constructed within the overall cell.

15. Climate Change Issues

Landfills contribute to the emission of methane once the biochemical reactions are stabilised and the organic fraction is broken down. However, reduction of methane emissions at urban landfills may not be cost-effective given the small waste quantities involved.

Locally the main effect of climate change on Solid Waste Management will be hotter drier summers, more intense rainfall events in the wet season and possibly more frequent/more intense extreme weather events.

The hotter and drier summers means that grass and other vegetation planted on previously worked areas of the controlled landfill mound may die due to lack of water and heat stress. This will be overcome by a conscious plan to collect and pump leachate over the vegetation to act as an irrigant. This has been done successfully at many other controlled landfills and Controlled Landfills.

The more extreme wet weather events can be managed at the controlled landfill by ensuring that the external batters are protected against erosion resulting from the higher rainfall intensities.

The master drainage infrastructure will be sized to account for the higher rain fall intensities to prevent stormwater runoff entering the operating cells and associated recycling areas and stockpiles.

A further effect from the more intense storms will be a greater amount of debris damage to be managed at the Solid Waste Management facility. This will be managed by using the chipper to be purchased in the future to produce valuable products from any debris including any branches and trees which are damaged during the more violent weather activities.

Alternatively a pit burner can be constructed at minimal cost to manage the additional tree and construction timber waste coming to the landfill after the storm events.

The time scales for climate change and waste management are similar. For instance, landfill sites can be operational for decades and still remain active for decades following their closure. Therefore, there is a need to consider potential changes in waste management over significant timescales and respond appropriately. In the Philippines, the main effect of climate change on SWM will be hotter drier summers, more intense rainfall events in the wet season and possibly more frequent/more intense extreme weather events. It is projected that the mean change in temperature increase would be 0.9 ^{o}C to 1.1 ^{o}C[3] and change in rainfall pattern would be -0.5% to 17.4% by 2020[4].

The rainfall and temperature can cause critical impact in each stage of ISWM such as waste collection, transportation and final disposal. The summary of impact of climate change across various stages of ISWM is discussed in.

Global Climate Risk Index 2015, Germanwatch[3]
[4]National Framework Strategy on Climate Change , 2010 - 2022

Table 15-1 Climate change impacts on ISWM

ISWM Activity	Climate change variable	Impact
Waste collection	Rainfall increase	• Increases moisture content and density of the solid waste to be collected. • Damages collection bins/facility • Washes out solid wastes washed along with storm water thereby decreasing the collection efficiency.
	Temperature increase	• Increases decomposition rate of solid wastes, resulting in insect infections and bad odour. • Damages collection bins/facility • Demands frequent waste collection from the collection centers. • Reduces productivity of the collection workers.
	Storms/wind flow increase	• Increases incidences of windblown litter. • Injures collection works due to windblown flying objects.
Transport	Rainfall increase	• Disrupts waste transfer due to flooding in collection centers, roads and landfill sites. • Increases weight of waste to be transferred due to increase in moisture content of the same.
	Temperature increase	• Increases frequency of waste collection to avoid rapid decomposition at the collection center. • Increases heat stress to the staff.
Final disposal	Rainfall increase	• Causes flooding of landfill sites, buildings, weighbridges, etc. • Alters the site hydrology. • Increases leachate generation. • Increases erosion and slope stability risks.
	Temperature increase	• Alters the waste decomposition rate. • Reduces productivity of outdoor workers. • Affects site infrastructures due to heat stress. • Increases stress on vegetation in site premises.
	Storms/wind flow increase	• Damages the site infrastructure such as buildings, offices, etc. due to high wind speed • Increases probability of dispersion of odour, infections, etc.

The consideration of adaption and mitigation measures at each stage of the ISWM system is an effective way to fight against the climate change impacts. The general climate change-related adaptation measures taken into consideration in planning the ISWM with the final controlled landfill disposal are provided in **Table 15-2**.

Table 15-2 Climate change adaptations/mitigation steps

No.	Project stage	Climate change adaptation/mitigation steps
1	Definition of the project scope	Impacts of climate change variables on ISWM project taken into consideration
2	Assessment of project feasibility	• Climate threats, vulnerabilities, impacts to solid waste collection, transport and disposal facilities assessed • Alternate options and mitigation measures identified
3	Project design	• Landfill properly sited away from floodplains, wetlands or areas with high water tables • Landfill site kept away from the drinking water supply sources • Design standards considered to strengthen the containment walls to accommodate future high winds • Water catchment systems designed that can keep pace with the projected rainfall patterns • Extreme event evacuation plan prepared
4	Construction, operation and maintenance	• Financial and technical resources considered assuming more frequent maintenance and repairs • Plans to prevent the erosion of landfill slopes, covers and roads into and around the landfills prepared • Storm water catchment systems designed to ensure proper function
5	Monitoring and control	• Regular inspection of the water catchment systems and the containment walls, particularly after extreme rains or storm events • Regular monitoring of the landfill site for its ground water table and possibility of contamination

Overall the impacts of climate change on the project infrastructure will be assessed, but initial indications are that they will be readily manageable. Thus, the overall impacts of climate change on the ISWM infrastructure will be assessed and adaptation measures will be considered during the design and implementation phase of the proposed ISWM.

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16. Privatisation Opportunities

16.1. Background

Expanding private sector involvement in the collection aspects is traditionally the most promising opportunity. It is critical to consider the length of contracts for privatisation success however. Short contracts of a year or two duration are insufficient to allow the investor enough time to recover Capex exposure. Any privatisation contracts requiring extensive capital injection by the operator must be at least 5 years in duration to recover investment costs in equipment such as providing a new waste compactor collection fleet, but a minimum of 15 years for buildings, plants and facilities , to allow amortisation of the capital cost,. At present, either individuals, NGOs or commercial companies are undertaking recycling activities. So there is little PPP opportunity for traditional recycling, unless at a very large scale such as adopting centralised composting or development of a mechanised material recovery facility.

Regarding the landfill operation, the private sector may be attracted to operation of large city landfills because greater scale of innovative technical or management solutions that will make the private sector more efficient than the City operating. Payment would usually be on a per ton basis, with operational performance style specifications setting out recycling, environmental and operational criteria. In that case, the City would change to becoming a regulator rather than an operator.

Another option for private sector involvement may be a composting or mulching scheme for greenwaste. Whilst a full scale centralised composting scheme for food scraps recovered from comingled waste is unlikely to be recommended for reasons listed elsewhere in this report, a composting scheme could be established in partnership with local agricultural companies. Such a public private partnership would require a private agricultural company agreeing to take and pay for the compost generated. A different ownership model such as a PPP may be appropriate and will be considered in the future when appropriate.

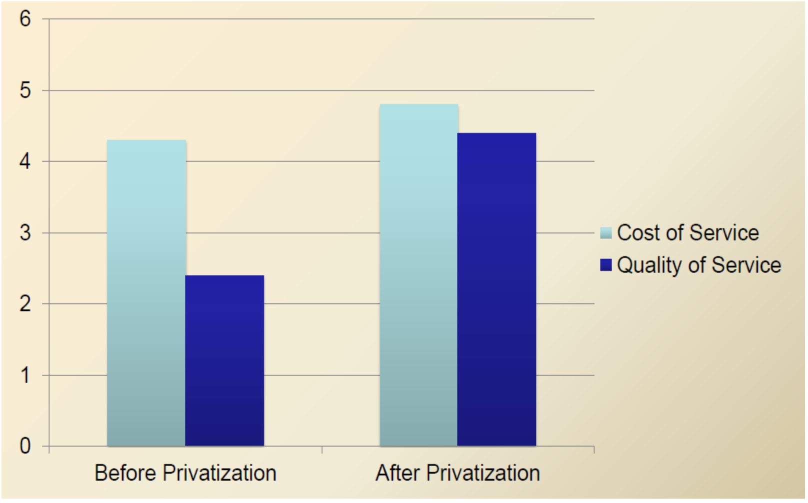
Even more critically than the payment agreement, there will be a need for the private company to agree to avoid any form of litigation against the City if the compost contains foreign objects such as glass, plastic or metal residues or other contaminants. Legal cases against the suppliers of contaminated compost have resulted in many plants closing in Europe and America.

These and other options for private sector involvement, particularly based on performance contracting, will be investigated during this project.

Most cities in developing countries look to experience private investors to finance, construct and operate WtE, Refuse Derived Fuel (RDF) and other similar projects.

16.2. Value for Money Concept

A key aspect that must be presented to the community is that privatisation does not necessarily lead to lower up-front fees or prices. The key factor is the “Value for Money” assessment wherein the service quality improves but the cost increases, but the cost does not increase as much (to reach the better level of service) if the old cost structure was simply extrapolated. The cost per ton of waste of collected reduces but the overall cost increases for example.



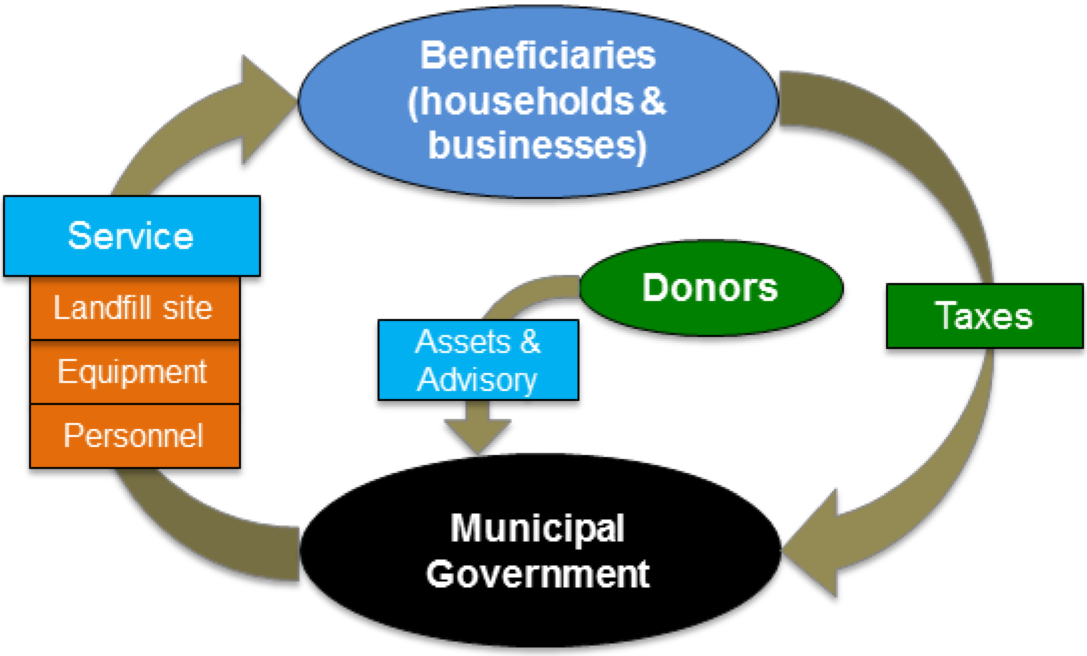
- **Figure 16-1 Quality of Service = Value for Money**

16.3. Modality Options for Privatisation

16.3.1. Background

The present public-based structure for ISWM is presented below.

Further details of some options are presented in **Appendix L – Privatisation Options.**



- **Figure 16-2 City-led institutional model for managing a ISWM plan.**

There are a large number of options for private sector involvement in Solid Waste Management. The options will vary depending upon numerous factors, such as the ownership of the equipment or the disposal site, such as a possible fleet of collection equipment including expensive compaction vehicles.

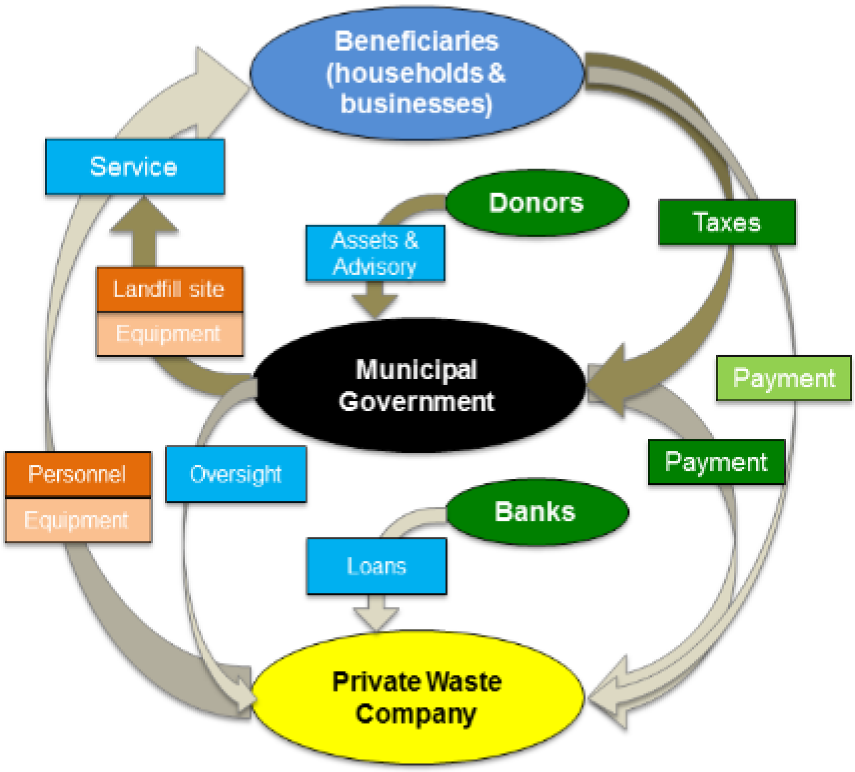


Figure 16-3 Public-private institutional model for managing an ISWM plan.

Operations and maintenance financing can come from a number of sources: municipal taxes, private fees, and donor/central government funds. Eventually for a program to be sustainable, it needs to be self-funding. A potential scheme could have these components:

- Private collection fees providing funds for primary collection to a community based organization or City,
- Municipal taxes providing funds for secondary waste collection, landfill operation and ditch/street cleaning.
- Donors providing funds for capital improvement and equipment.

Noting the restrictions on household collection fee imposed by recent court rulings, the City will continue with its attempts to initiate the collection of the cleaning tax from the population as part of the municipal budget reconciliation process. Payment of private fees must be encouraged through education, transparency and community communication and participation in the neighbourhood cleaning activities.

16.3.2. Service Contracts

These delegate particular operations and maintenance (O&M) functions to a private operator for a short period of time (one to two years) in return for a specified fee. These could be appropriate for operating a Controlled Landfill or collection services if the scale of the operation is sufficient.

16.3.3. Management Contracts

Service contracts allocate responsibility to a private operator for the full range of O&M decisions, typically for three to five years, or longer. The private operator is paid a fee, which may sometimes be linked to performance. It could be appropriate for operating a landfill if the scale of the operation is sufficient.

16.3.4. Build Operate Transfer (BOT) contracts

BOT contracts give the responsibility to a private operator (or consortium) both to finance and construct an infrastructure facility and to operate and maintain it for a specified period of time. At the end of an agreed period, ownership of the facility is transferred to the government at a symbolic cost.

The private operator retains all the revenue from operating the facility for the period of the contract, to pay for the capital and operating expenditure. This revenue stream typically consists of fees paid by the public sector user and commercial operators.

These contracts are only appropriate for large landfill operations, a major landfill or perhaps for a very large mechanised MRF (Municipal Waste Facility). This is not the present situation in the city, but may become the case in the future.

16.4. Summary Table of Options

- **Table 16-1 Summary Table of Privatisation Options**

Service Contracts	Management Contracts	BOT/BOOT
Promotes competition when contracts are bid. Contracts can be re-tendered every 1-5 years.	Promotes competition when contracts are bid. Contracts can be re-tendered every 3-7 years.	Takes over management of operations from government, but concession term must allow return on capital. (15 to 30 years)
If contract fails, risk is relatively low.	Can improve service while retaining public ownership.	Full responsibility for operations, capital raising and investment goes to private sector.
Duration - if problems with contract — can easily re-tender.	Potential first step to concession contract.	Potentially large improvements in operating efficiency of assets.
Easy/Simple contractual form.	Potential for setting performance standards (with incentives to achieve standards).	Mobilises private finance for new investments. Addresses funding shortfall
Potential starting point for private sector participation.	Reduced risks to government and contractor.	Full private sector incentives across utility.
Can increase utility's focus on core business	Can revert to in-house management or contract, may be re-tendered if problems arise.	Attractive to private financial institutions.
Potential for efficiency gains in the area covered by contract	Potential for utility to bring in competition.	Contracts are complex. Need parity in negotiating strength to achieve fair outcome.

16.5. Suitable Aspects for Privatisation Locally

16.5.1. Waste Segregation and Recovery

Waste segregation is the sole purvey of the waste generator, be it a household, institution or a commercial operation. Therefore there is no role for privatisation in waste segregation, apart from perhaps an educational role in encouraging waste generator compliance or perhaps funding the provision of separate bins for the various waste streams.

Waste recovery is already happening in the City at the household and waste generator level. In the household, recyclables are generally being recovered, particularly items such as aluminium and glass. There is no role for external privatisation of these roles apart from perhaps a private involvement in the necessary education campaigns to encourage segregation and materials recovery at source.

Overall, the possible role for the private sector in this phase of ISWM is opportunistic and not commercial.

16.5.2. Collection

Apart from a small number of Barangays who collect their own waste, most waste is collected by private sector contractors.

The only shortcoming is that the contracts are let annually which impacts upon tenderers providing purpose built compaction equipment and use open dump trucks instead, which are far less efficient.

16.5.3. Recycling/Composting

Traditionally Municipalities only support recycling companies and do not compete with these private entities such as corporations or NGOs.

The City may provide assistance in kind, such as allowing access to vacant land at the landfill for recyclables stockpiles or providing a compactor or chipper. But the aim is always to support the private sector and not compete by establishing their own Municipal schemes.

16.5.4. Disposal

The Payatas disposal site has been privatised for over a decade.

Due to high level technology and environmental requirements for WtE facilities under Philippine law, the financing, construction and long term operations of such facilities would be undertaken by appropriated qualified private sector investors under a Build-Own-Operate Transfer model

16.6. Adopted Approach

The City has decided that the present level of private sector involvement is appropriate, and as such proposes to continue to involve the private sector in all aspects of ISWM with expected near term private investment in a WtE project. The prefeasibility study under this RETA 8566 will focus on the City's first expected WtE project.

17. Analysis of household behaviours, attitudes, and beliefs

17.1. Introduction

QC has completed Citizen Participatory Audits in 2013 and 2015 relating to community understanding and commitment to sustainable SWM.

The results are very encouraging indicating both a good understanding and appreciation of the City's efforts including IEC campaigns and levels of service support.

The second survey showed that a majority of the respondents are satisfied with the cleanliness of the City as 71% gave an overall mark of "clean to very clean" and only 1% gave a "dirty" mark.

In terms of satisfaction with the way garbage was collected in the communities, 94% of the respondents are satisfied with the garbage collection service of the City as signified in their survey responses.

The survey also showed that the community is aware of the Information, Education and Communication (IEC) Campaign of the City as 82% expressed their awareness to such activities. Majority of the respondents (73%) also practice waste segregation at source. Lastly, the survey showed that the City's system of collection is properly carried-out since segregated garbage collection was done according to set schedules.

The results are consistent with the first survey conducted in 2013.

In addition the City may consider expanding these Audits with a wider analysis generally aimed at understanding the community behaviours, attitudes and beliefs about SWM, so future IEC and other activities can be efficiently focused to maximise returns for the City.

17.2. Focus

The target audience is all residents in QC, specifically households using a collection service, individuals who litter, and school children.

The key behaviours which are the target for any social marketing and behaviour change campaign are:

- To get households to dispose of rubbish into public bunkers and bins;
- To stop dumping of rubbish into drains and casual littering;
- To minimise waste including increasing recycling and reuse;
- To reduce damage to bunkers and bins.

17.3. Opportunity

17.3.1. Socially acceptable behaviour

Solid waste behaviors which are accepted locally in the less prosperous areas are:

- Dumping rubbish – on to vacant land and in drains and rivers, into the sea;
- Casual littering - after eating outside, from vehicles, any situation;
- Burning rubbish;
- Waste picking through bunkers for food for animals and for recyclable materials;
- Using excess plastic bags.

17.3.2. Fines and Sanctions

The City's Terms of Reference (TOR) for the Solid Waste Cleaning, Collection and Disposal Project remains to be one of a kind as it does not only include the collection of garbage but also other complementary components which include street sweeping activities, cleaning and clearing operations as well as enforcement of environmental laws and information dissemination. These components ensure the overall upkeep of the City cleanliness.

The improved "Zero Litter Campaign" was implemented by the EPWMD to serve as a total clean-up strategy for the City which includes the apprehension of violators on proper solid waste management, cleaning and beautification, clearing of obstructions and massive IEC campaign through distribution of letters and IEC materials.

To date, 1,000 Notices of Violation (NOV) and 7,557 Environmental Violation Receipts (EVR) were issued as a result of the various operations conducted by the EPWMD. As of December 2015, PHP 1,282,800.00 has been generated through the collection of fines and penalties from violators apprehended.

This achievement can be attributed to the additional manpower given to the EPWMD as well as the full cooperation of Barangays. The EPWMD, through its Monitoring, Inspection and Enforcement Section, regularly conducts Environmental Management Deputation Seminars to deputize Barangay Environmental Enforcers (BEEs) as endorsed/ requested by the respective Punong Barangays from the Six (6) Districts of the City.

These seminars are being conducted to train and inform the applicants, relative to proper solid waste management, Environmental City Ordinances and simulation cases. Applicants were evaluated based on the written examination and the completion of the seminar-workshop conducted.

The whole Quezon City now has a total of 633 Deputized Environment Police, 89 of which are from EPWMD, 376 are from the 70 participating barangays and 168 are the Solid Waste Management IEC Campaigner cum enforcer. This number is expected to increase as other barangays have expressed their willingness to participate in the program and have their personnel undergo the Deputation Seminar.

The EPWMD also implemented its Green Desk Expansion Project which aims to strengthen the implementation of the City's Ordinances on environmental protection policies through a partnership with the Quezon City Police Department (QCPD).

Through this project all 12 police stations appointed their respective Green Desk Officers, where residents can file and report cases of violations of environmental laws and ordinances.

17.4. Ability

17.4.1. Knowledge

According to individual residents, focus group participants, NGOs, and EPWMD Audits, public knowledge on the environmental impact of rubbish is still too low. It can be reasonably assumed that people have limited knowledge about different materials and their decomposition time, or on how to minimise waste generally.

17.4.2. Social Support

Social support is provided by families and importantly by neighbours. In fact neighbours can be quite close and be respected in the community as important sources of information. Local leaders can mobilise social support and implement government policies.

17.4.3. Affordability of Solid Waste

The main constraints to affordability of solid waste services are unemployment and low incomes.

17.5. Motivation

17.5.1. Attitudes, Beliefs and Drivers

Consultation and research has revealed a common theme that people are proud and supportive of QC. Their desire to support the country, its people and the goals of government came up in many different interviews and meetings.

Past surveys indicate a concern for the environment with solid waste being one of the main contributors to poor environment. Caring for the environment is important but environmental problems are often seen as the responsibility of government and not individuals. Concern has also been expressed about burning rubbish and potential health impacts, or that rubbish generally can lead to malaria, as well as solid waste in drains and rivers causing blockages and flooding for people downstream.

Some important drivers for behaviour change are care for the environment, and respect for neighbours – for example people have to live closely with neighbours but may not be aware the impact of their solid waste disposal actions are on them.

Important feedback from several key informants is that a practical approach is needed to motivate people, in other words people must be shown what to do, not just put up a regulation or talk about how to do it. This requires direct engagement with households at the Barangay level.

18. Information, Education and Communication Campaign

18.1. Introduction

The ISWM Plan must address sustainability issues and not just engineering interventions. So an Information, Education and Communication (IEC) Campaign is essential to upskill and educate the community, city and agency staff and civil society on many aspects of ISWM, ranging from health and pollution impacts to waste minimisation and segregation benefits in the future.

Historically there have been some national, city-based and local community awareness programmes on Solid Waste Management.

It is critical to engage with the community and civil society to bring about a better understanding of the key waste management issues relating to the environmental and health impacts of poor waste management, waste avoidance, minimisation, reuse, recycling, household composting and the increasing need in the future for waste segregation, especially green waste. In summary, it may involve items such as the following:

- Household, community and school meetings involved;
- Literature and pamphlet content to be developed based on existing sources;
- Organize activities integrated with programs in schools, cultural and other venues;
- Organize thematic seminars noting the current state of the environment so that there are specific activities designed to meet the IEC objectives;
- Training will eventually need to extend to the City residents generally and ISWM staff specifically.

In detail, the IEC will need to address stakeholders and issues such as the following as a minimum:

- The community on waste minimisation, reuse and recycling;
- The community on using food scraps for animal feed or home/commune composting;
- The community on the impacts of illegal dumping and littering;
- City staff, waste pickers, site workers, equipment operators and so on for general controlled landfill recycling and disposal operations;
- The community and city staff on segregating waste as it may be required in the future
- Any waste pickers educated on the risks and hazards of being exposed to waste and need for wearing suitable Personal Protective Equipment (PPE);
- Hospital and medical centre personnel on segregation of medical waste;
- The cost implications of providing a higher service standard for both collection and disposal activities.

There is plenty of ready-made literature, and training materials, that can be used and would be available through the multi-lateral donors and International nongovernment organizations (INGOs). For example, a specific education component would be household waste segregation and household based composting and a pilot scheme could be established in one commune. This will require protracted assistance from training organisations, such as a local NGO. Usually such schemes are run by a local NGO with local contacts and a vested interest in the sustainability of the outcome.

Some possible options are listed in the **Table 18.1 – Typical IEC Components** below:

- **Table 18-1 Typical IEC Components**

Item	Issues	Approach
Environmental Management	Burning garbage causes air pollution and health risks	Explain the environmental damage caused by garbage fires
Environmental Management	Illegal disposal of garbage into creeks, rivers and vacant lots	Explain the environmental damage caused by illegal garbage dumping and littering, and the prosecution liability.
Waste segregation	Essential if mechanised recycling and composting schemes are to be efficient, but costly to have the necessary different receptacles and collection services.	Explain how to do this. Start at Household. level if segregation is desired.
Waste minimization	Purchasing products with the least amount of packaging	Education on benefits of less cost of collection and wasted materials and landfill space consumed
Waste Toxicity	Reduce toxicity of products purchased and segregate hazardous waste for separate collection and disposal	Education on alternatives to certain chemicals, e.g. natural toilet cleaners
Reuse	Reusing containers, such as bottles	Education on benefits as per packaging reduction and other sources
Recycling	Recycling containers, such as plastic bags for garbage containers	Education on benefits as per the above. Also need to market en masse for better prices (e.g. plastics and glass) and also obtain market access e.g. for sale of tin cans
Recycling	Drop off centres for selected items	Consider a centralized system for whitegoods, garden or green waste, hazardous waste, etc
Organic reuse composting	Do it at Household?	Training on methods and equipment required. Market development for local product. Also consider vermiculture? Encourage feeding of domestic animals
Greenwaste	How to manage yard and tree clippings	Chipper needed at the landfill in future. Chipping for mulch for composting is also an option
Privatisation	Community concerns abput cost and reliability/level of service	Community awareness on Value for Money concept, supported by success stories such as Herat.

The benefits will include:

- Compliance with local regulations;
- Community educated about the socio-environmental impacts of poor waste management;
- Community more willing to pay for better service;

- Enhanced recyclable recovery rates. This will be incremental initially and then a major increase when greenwaste and construction and demolition waste are recycled in future years;
- Educated community on waste minimisation and the 3Rs (Reduce, reuse and recycle) including household composting where appropriate.

It has been mentioned in previous studies that the successful implementation of any solid waste management strategy would rely both on an increase in awareness of solid waste management issues and the related firm commitment to resolve waste management issues among the key stakeholders.

These stakeholders include among others, non-government organisations involved in environmental concerns, junk dealers, professional organisations, local government officials (Neighbourhood and municipal/provincial) national government agencies and the industry sector.

Another equally important factor to the strategy is the training aspect for the identified stakeholders on the elements of a solid waste management system and the specific environmental concerns.

18.2. Possible Community Training Elements

The following items listed in **Table 18-2** should be considered when developing the detailed training and education program on the ISWM program component.

- **Table 18-2 Typical Training Components**

Item	Issues	Household/Neighbourhood	City/ Province
Environmental Management	Burning garbage causes air pollution and health risks	Explain the environmental damage caused by open garbage fires	Ordinances
Environmental Management	Illegal disposal of garbage into drains, rivers and vacant lots	Explain the environmental damage caused by garbage dumping	Ordinances
Waste segregation	Essential if recycling and composting schemes are to be efficient, but costly to have the necessary different receptacles and collection services.	How to do this. Start at Neighbourhood and Household. Possibly use Neighbourhood eco-aides to collect compostables and recyclables with only one City pick-up service.	Legislation requires segregation
Waste minimisation	Purchasing products with least amount of packaging	Education on benefits of less cost of collection and wasted materials and landfill space consumed	Container Deposits
Waste Toxicity	Reduce toxicity of products purchased	Education on alternatives to certain chemicals, e.g. natural toilet cleaners	Legislation
Reuse	Reusing containers, such as bottles	Education on benefits as per packaging reduction and other sources	Legislation
Recycling	Recycling containers, such as plastic bags for garbage containers	Education on benefits as per the above. Also need to market en-masse for better prices (e.g. plastics and glass) and also obtain market access e.g. for sale of tin cans	National recycling market studies
Recycling	Drop off centres for selected items	Consider a centralised system for whitegoods, garden or green waste, hazardous waste, etc	
Composting	Do it at Household or Neighbourhood levels?	Training on methods and equipment required. Market development for Neighbourhood product. Start at Neighbourhood and then go to Household? Also consider vermiculture?	Establish sustainable markets for compost
Greenwaste	How to manage yard and tree clippings	Chippers at Neighbourhood level as input to composting perhaps. Chipping for mulch not composting is also an option	Can the chipper be funded?

Items required will include the following, but the full list of requirements will have to be developed in consultation with the training and education specialists, as well as the City participants;

- primers (why bother segregating, recycling, etc),
- facts sheets (how to compost and what to look for when operating a compost)
- presentation material for our specialists to “train the trainers” such as NGO’s, Neighbourhood officials, etc. to roll out the program to the community
- presentation material for the “trainers” to use at the actual training and education at the future Neighbourhood meetings or household meetings, NGO meetings, etc.

The recommended approach is the “train the trainers” methodology, in which nominated person swill be identified to roll out the full information and education program.

A second element will be introducing educational material into the school curriculum. This is a longer-term issue that will require support at Provincial or National level prior to implementation.

18.3. Possible Communications Strategy Elements

18.3.1. Institutional responsibility

The primary entity for a social marketing campaign should be the City Administration as it has a direct link with solid waste management service delivery through the EPWMD. Other organisations can play an important supporting role however solid waste is not their mainstream responsibility.

This department would be the information hub for everything to do with solid waste: they must know who the recyclers are, what they are doing, who to contact, not just so they can give advice to the community but so they can connect with recyclers, composters, community groups, and waste organisations to participate in key events.

Given that community awareness needs to take place at times which are suitable for the community, the Department and others implementing awareness activities need transport and other resources to get to the community and need support to work out of normal business hours – typically the weekend and evening.

Based on the analysis of behaviors, institutions and communication channels, the approach for improving waste behavior is through four main methods: television spots, community outreach, schools program, and general demand based awareness.

18.3.2. Mass media awareness through television spots

These would be prime time advertisements to increase sensitivity and change attitudes about socially unacceptable waste behavior such as littering and dumping. These spots will start people thinking about how their behavior is affecting others such as neighbors, or people downstream (i.e. actions have consequences) and how rubbish does not go away just because it is thrown away.

A prominent local or National personality could be featured as a way to attract attention and importance. These spots would be a high priority and can be started early in the project. Although they are targeting residents through local media, the spill over into other urban centers and rural areas will not be wasted as the messages will be relevant for those living in other areas or for people who come to the City from outside areas.

18.3.3. Schools program

Given that youth are the future adults, they are already involved in rubbish disposal, they can be influenced by information and can carry that knowledge back to their homes, and they are a growing section of the urban population, schools and school children are targeted for a special program.

Children are expected to do some simple critical analysis in both natural sciences and social sciences. The curriculum should be continuous so even Grade 1 children learn about rubbish and this is carried through other grades at different levels.

For primary schools awareness would be through visits, talks, demonstrations, and action games by a contracted NGO, together with materials that support the new school curriculum e.g. posters, stickers, information packs.

For secondary schools, the emphasis would be on school talks and provision of reference material for student research and assignments.

Specific materials should be developed which are appropriate locally.

Additional activities could include school competitions within the urban areas e.g. art competitions which link art with rubbish themes (the artwork is then made into a calendar, providing 12 months of waste messages); sponsorship of a writing or poem competition about waste and the environment to support literacy; song competitions; video competitions (e.g. using a mobile phone camera); fashion event. Publicising of winners through mass media also brings attention to solid waste issues.

18.3.4. General awareness

General community awareness would be provided by the Department on a demand basis and could include talks to businesses and community groups, radio/TV shows and panels, newspaper articles etc. Special events could be added such as organising a show on recycled art; entertainment around World Environment Day (June 6); competitions around International Recycling Day (May 17). The Department could also develop special campaigns as needed such as plastic bag reduction (minimising at point of sale through awareness of both customer and teller, use of green/reusable bags). Where possible the Department should bring in the particular knowledge of specialists such as composters, recycling companies, collection service managers.

18.4. Communications Approach

As frontline staff interacting with the community on a daily basis, waste collectors (both contractors and staff) should also have basic training in waste: how waste breaks down, the collection service, what is recyclable, who is recycling etc. This could be combined with health and safety training.

A short course will need to be developed which should be delivered twice per year and updated accordingly.

- **Table 18-3 Communication Methods Options**

	Behaviour change method	Informative method
Mass media	Television advertisements Short informational videos on key themes	Television interview, panels, news articles Radio talk back, radio panel Newspaper article
Community Outreach - Key informants	Training of community leaders (direct talk, informational video, leaflet, posters)	Other briefings e.g. government (direct talk, PowerPoint, informational video, leaflet)
Community meetings	community meetings (demonstration, informational video, leaflet, posters)	Interest group meetings e.g. businesses; women's groups (PowerPoint, demonstration, informational video, leaflet, poster)
Schools	Primary school talks, demonstrations, games (video, poster, leaflets, guide) Secondary school talks, information pack (video, posters, fact sheets) Teacher training	Competitions School magazine
Other	Training of waste collectors (video, demonstration)	

18.5. Delivery

A professional approach is important for effective communications, and using a local company also provides opportunity for employment and skills development, while at the same time developing content which is relatable to the majority of the target audience.

New materials must be developed and old ones updated to be tailored to the local situation and the use of materials and approaches simply copied from other countries avoided. There is a risk that the messages miss their target and are ineffective unless they are carefully researched and developed.

School materials may be developed by NGOs and specialist education staff or by a communications company. This will require Regional or National inputs.

Change champions and respected leaders can be effective at influencing attitudes and behaviour however there is a need to choose carefully those who model good behaviour, not those that are promoting a certain cause then demonstrate the opposite behaviour. A spokesperson should be chosen not just for their fame but also for their personal commitment to the environment.

Change champions should also be selected closer to the time of implementation and service change, as popular public figures may change. It is critical to have a popular figure, even if that person wishes to charge for their services, to attract people to various events and bring attention to the campaign.

18.6. Coordination

It is critical that the EPWMD staff coordinate with other agencies involved broadly in solid waste management, and one such opportunity is through a new ISWM Committee and Working Group. This would be a way to coordinate with other departments and ministries, civil society, NGOs, and so on. Other organisations may be included in the committee/working group and from the private sector and possibly recyclers.

18.7. Monitoring

How community awareness is carried out has a potential wider implication for further awareness in other Municipalities. Therefore it is important that both the method and impact of the awareness is monitored. A few simple key indicators should be developed which could be used on annual basis to monitor changes in waste behaviour. These could include recycling volumes, littering and problem dumping area observations (photographed annually), surveys on attitudes to waste and disposal behaviour, attendance at public events, recall on littering/dumping/recycling messages.

18.8. QC IEC Content and Delivery

18.8.1. Introduction

The main purpose is to enhance people's awareness, knowledge and understanding and to promote active participation of all stakeholders in the program by adopting the desired waste management practices such as segregation and reduction through reuse, recycling and composting. This is based on the premise that an informed constituency is the key to public acceptance.

Components of this section shall be implemented based on a prioritized target audience. Evaluation of the stakeholders' appreciation on solid waste management will be continuously updated to suit the changing needs and conditions relative to the implementation of the Ecological Solid Waste Management.

IEC efforts will be complemented by putting in place an effective and efficient method of collection, transport storage and disposal.

The strategy for implementation in the IEC will be carried out aspiring to achieve the aim of the City to be a model where all of its barangays are practicing segregation at source and segregated collection.

Through the EPWMD, community-based IEC program shall be conducted to ensure that all areas in the barangay are saturated.

18.8.2. Core Messages

Generally the IEC materials that will be developed shall follow the fundamentals of the waste management hierarchy. These are as follows: source reduction and minimization of wastes generated at source; resource recovery, recycling and reuse of wastes at the barangay; efficient collection, proper transfer and transport of wastes by the City and; efficient management of residuals wastes.

An inventory of existing IEC materials on ecological solid waste management shall be conducted to determine which will be appropriately used for the campaign. New IEC materials will be developed based on the said inventory. Various types of IEC materials will be utilized in the conduct of program implementation. Print materials such as fliers, leaflets and posters will be developed as collateral materials for community orientations. Billboards will be established in strategic areas to improve chances of messages being remembered by the target audience. Moving films and negatives such as the information commercials shown and viewed in theatres, cinemas, televisions and other similar areas will also be utilized.

Linkage to other partners such as but not limited to media groups, socio-civic organizations, Pos, NGOs shall be established. To ensure the support of these groups in the IEC campaign, it shall be formalized through a Memorandum of Agreement defining the roles of each agency/organizations involved. Regular feed-backing and assessment will be conducted with the partners.

18.8.3. Approach

The first phase of the campaign will be the conduct of series of meetings, orientation and briefings with identified foundation of champions and connectors. These shall include barangay and SK officials, purok leaders, socio-civic and religious association officers and other organizations with networks. A forum on SWM will be conducted with these stakeholders where they shall be requested to influence their constituents to practice waste segregation and management.

Current SWM initiatives of the academe will be sustained and expanded to include other areas of waste management (i.e. composting and livelihood from recyclable materials).

Specifically, to ensure participation of the general public for integrated solutions for waste management, the City shall implement the following IEC projects:

- City-wide Slogan Contest on Environmental Concern
- Household with best SWM practice (Brgy, level contest)
- Barangay with best SWM practice (City-wide contest)
- Barangay with the highest percentage household compliance on waste segregation contest (City-wide)
- Well organized barangay in the implementation of SWM contest (City-wide)
- Cleanest and Greenest Barangay Contest (City-wide)
- Poster Making Contest on SWM and environmental concern (City-wide)
- Best effigy/mascot contest for Quezon City (e.g. super waste manager, super basurero, Recycling man, composter man, etc.)

- Poem Making contest on environment concern (City-wide)

Advertisements through tri-media will be done in the conduct of the contests.

The following educational programs or public education shall be conducted by the City to encourage the constituents to participate in the integrated solutions for waste management:

- Demonstration of Household Composting Process and other ecological system of waste management in television/radio talk shows, film clips and the like.
- Proposal to include in the curricula in the primary and secondary schools the study for the protection of environment and waste management.
- Movie advertisement on proper household waste management.
- Billboards advertisement on proper waste management to be installed in strategic areas.
- Establishment of Training Centres for waste management.
- Conduct series of orientation/seminars on waste management in the barangay.

For the educational program to be successful, the City shall develop different ways to sustain the program in order to encourage, draw and sustain interest among the people. The following strategies shall be provided:

- For TV, Film clips demonstration on waste management. The City shall allocate annual funds for the payment of airtime in the showing of the demo system. The film clips will show the benefits in practicing ecological waste management system in terms of money, health and cleanliness of the surrounding and love of nature.
- For the proposal to include in the school curricula. The City through the Board and EPWMD shall formulate a subject module on waste management. This will be indorsed to the Department of Education for the inclusion of the same as one subject or sub-subject to the primary and secondary school.
- For movie advertisement on waste management. The movie ads on proper waste management will be shown in all movie houses in the City as intermission to regular movies. The City shall allocate annual funds for the production and showing of the movie advertisement on waste management.
- For billboard advertisement. The billboards to be installed will be large enough to catch the attention of the general public and to be placed in strategic places.
- For the establishment of training Centre. Similar to the National Ecology Centre, the City shall establish a training Centre, which shall provide consulting, information, training and networking services for the implementation of the City's Solid Waste Management Plan. The City shall allocate funds for the establishment of this Centre which includes the provisions for the salaries of trainers, consultants and other necessary expenditures for the sustenance of the program. As such, the Centre shall have the following sustenance program:
    - Facilitate training and education in integrated ecological solid waste management
    - Establish and manage a solid waste management information database

- Promote the development of a recycling market through the establishment of a City's recycling network that will enhance the opportunity for recycling
- Provide or facilitate expert assistance in pilot modelling of solid waste management facilities
- Develop, test and disseminate model waste minimization and reduction auditing procedures for evaluation options

- For the conduct of orientations/seminars on SWM in the barangay. The City through the Board and EPWMD shall provide competent Trainers and coordinators to handle orientations/seminars on solid waste management in all barangays. Materials such as flyers, brochures, and other visual aids will also be provided.

18.9. Summary of QC IEC Content and Delivery

The above sections provide an overview of the possible content and delivery approaches, and the City has already implemented the following to raise the level of awareness of the public on the various environmental laws and policies implemented by the City, a comprehensive IEC program is being implemented to achieve the widest participation and support in implementing as well as advocating projects/programs on environmental protection, more specifically on solid waste management.

The following were employed to achieve this purpose:

- Showing of cinema infomercials about Quezon City's Solid Waste Management Program entitled Clean, Clean QC.
- Showing of advertisements and infomercials on environmental protection particularly on Reuse, Recycling and Composting in all 82 movie houses in Quezon City (VCD copy) in 2004.
- Distribution of instructional materials to 142 barangays, 97 public elementary schools, 297 private elementary schools, 45 public high schools, 177 private high schools and 49 Health Centres within the City.
- Hosting of "Earth Day Jam" in 2004 to 2007, a musical tribute to Mother Earth, attended by well-known environmentalists, musical artists, and people from Quezon City and nearby cities.
- Conduct of comprehensive IEC Campaign in barangays with SWM Programs as part of the implementation of separate collection or the "No Segregation, No Collection" scheme.
- Distribution of the Honourable Mayor's open letter to business establishments in the City regarding maintenance of cleanliness in their premises.
- Deployment of Solid Waste and Environment Education Program Coordinators (SWEEP Coordinators) in the year 2004 as lecturers and campaigners in the implementation of waste segregation and other environmental programs.
- Deployment of IEC Campaigners provided by the City Garbage Contractors on the door-to-door collection system in inaccessible areas and other concerns about the garbage collection system of the City.

In the course of implementing these projects, the following were observed as the resulting impact of the massive IEC campaign:

- Increased public awareness on environmental laws, ordinances and other policies as manifested by several requests for deputation as Environment Police from private citizens and several barangays expressed their willingness to be stewards of the environment.
- Increased awareness on the benefits of proper solid waste management, particularly waste segregation at source, as manifested by the increased number of requests from schools and establishments for the conduct of seminars on proper SWM.
- Awareness on the benefits of proper solid waste management resulted to the reduction of 11.45% waste volume intake at the Payatas CDF or approximately 23,422 cubic meters per month reduction from January to May 2005.
- Increased requests for EPWMD to provide technical assistance and guidance on SWM implementation.
- Compliance to the No Segregation, No Collection scheme implementation increased as manifested in the reduction of truck requirement per area and consequently, an increase in the solid waste diversion in every barangay.
- Solid Waste Management Programs were also implemented by schools as a result of the continuous IEC campaign. Tapping the future leaders of the country would ensure continuity of efforts towards waste reduction. Also, through the different strategies employed, it was able to instil stewardship, accountability and to a certain extent, values change among the youth.

19. Costs

19.1. Background

The indicative costs below are based a 1000tpd WtE facility. The actual size of the facility will be agreed following the daily mass tonnage audit in October.

Also the costs below do not include an allowance for land purchase which will be significant. Again the area required depends upon the size of plant agreed but at least 10 hectares will be required.

- **Table 19-1– WTE Facility CAPEX** [5]

EPC Capex items	Approximate %	Amount
Waste Reception, Incineration and Heat Recovery System	32%	US$ 75,200,000
Flue Gas Treatment and Ash Handling System	10%	US$ 23,500,000
Leachate Treatment System	6%	US$ 14,100,000
Building E&M, Process Control and Monitoring System	9%	US$ 21,150,000
Civil, Building Structural and External Works	25%	US$ 58,750,000
Others (incl. Preliminaries, Detailed Design, Construction Supervision etc.)	10%	US$ 23,500,000
Contingencies	8%	US$ 18,800,000
Capex total	100%	**US$ 235,000,000**

- **Table 19-2 WTE Facility OPEX**[6]

Opex items	Approximate %	Annual Expenditure
Chemical and consumables	10%	US$ 1,478,250
Operational staff	15%	US$ 2,217,375
Routine maintenance, repair and overhaul	35%	US$ 5,173,875
Treatment of leachate and ashes	20%	US$ 2,956,500
Utilities	10%	US$ 1,478,250
Others	10%	US$ 1,478,250
Opex total **(i.e. US$ 41/tonne)**	100%	**US$ 14,782,500**

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Any opinion expressed by AECOM concerning the revenue, CAPEX and OPEX is based on the generally accepted engineering practice in effect at the time of the assignment and information that has been supplied to AECOM by the Client and others in connection with the assignment. Any indication of cost would be in the form of an 'order of magnitude estimate', which should only be considered as an early indication of cost and in no case be considered as the actual costs. Such opinions are subject to risks and uncertainties that are beyond the control of AECOM. The passage of time may result in changes in technology, economic & market conditions, competitive factors, site variations, new products, company's policy or regulatory provisions which would render the opinions inaccurate. Thus AECOM makes no representations or warranties with respect to such opinion or recommendation and disclaim any responsibility for the accuracy and completeness of any opinion or estimates.

20. Resources and Funding

20.1. Identify Project Costs

A typical review of the ISWM costs would have to include items such as the following;

- Fuel
- Direct labour costs, including vacation and leave provisions
- Equipment repairs and maintenance
- Overhead costs, such as senior City staff management and support staff
- External costs, such as non-City staff costs for legal advice, etc.
- PPP obligations if any
- Any promotional and education costs, and
- Miscellaneous costs

20.2. Internal Funding Opportunities

The preferred overall approach is to institute methods of City charging which are;

- Direct – the people generating the waste actually pay for their waste,
- Enforceable – non-payment means termination of service
- Adequate for future provisioning – sufficient funds to not only operate day-to-day, but also to invest in a sinking fund for future Capex obligations, such as a new landfill dozer or collection vehicles

20.3. External Funding Opportunities

There is a number of possible external funding mechanisms available to the City as follows;

- Grants
- Subsidies
- National Funds (Special project funds, such as demonstration projects possibly)
- Local funds of some type
- Donations – cash or in-kind, such as land
- Incentives

This is related to the objective of providing finance to Municipalities for capital investment in ISWM infrastructure and cost sharing basis with National government accepting its share of the responsibility of upgrading an essential public health service, alongside Municipalities and the private sector. The purpose of the financing program is to assist in the achievement of an improved environmental method of managing municipal solid waste. The financing program will complement the strategy by providing supplementary financial resources necessary to achieve the strategy objectives in a properly coordinated manner within a reasonable time frame.

The financing program will not be a substitute for municipal funding. Rather by providing finance for capital expenditure, it is intended to serve as a catalyst to encourage self-sufficiency, in releasing municipal funds for the operational costs of waste disposal as well as waste collection.

The principal purposes of the financing program are:

- to provide Municipalities access to the kinds of investment finance required by developers of any large capital works project; and
- to act as a catalyst to bring about improvements in municipal financial management.

In particular it is intended to rationalise the somewhat *ad hoc* procedures, which currently characterise funding for solid waste management.

20.4. QC Costs and Financing Options

20.4.1. Investment cost

Section 10 of the Ecological Solid Waste Management Act of 2000 specifically stipulates that the local government units have the primary responsibility to provide solid waste management services. Local governments must rely on a variety of financial resources to fund the services. A mixture of resources may be used for financing the various components of waste management system such as collection, transfer, resource recovery and residual waste management.

The City's Solid Waste Management Plan includes capital investments for the following solid waste management facilities:

- Sanitary landfill
- Materials Recovery and Compost Facility for the City

However, the estimated capital cost together with the detailed engineering design and construction of these facilities will not be included in this plan since its systems and operations will be coursed through the private sectors through the most suitable financing scheme. Likewise, investment for collection vehicles, including the collection system will also be privatized.

20.4.2. Annual Costs

In order to generate sufficient revenues to cover the cost of solid waste service, the government should have a thorough understanding of the actual costs associated with providing the service. Unfortunately, very rarely are the costs fully known.

20.4.3. Funding Options

Four (4) financing capital investment will be explored: reserves, bonds, loans/grants and donations. In each options, the community issues tax-exempt debt and guarantees repayment of the debt with credit of either the community or the project's revenues combined with any other guarantee or insurance.

Reserves

In this particular case, the LGU shall receive and save a portion of current revenues for the sole purpose of financing capital investments. Reserves are known also as renewal funds and usually are used for investments in equipment replacement or to extend the service capacity of existing equipment.

Bonds

Another way to obtain financing for capital investments is to raise funds from private investors through the issuance of bonds. Public ownership of solid waste management system or facility generally results in one of three financing methods:

- General Obligation Bonds. This type of financing utilizes the credit of the community as the credit pledge. Principal and interest payments for general obligation bonds can either be made from tax revenues or from the project's revenues.
- Revenue Bonds. This type of bond is repaid from revenues generated by the project or system. The bonds are secured by legal documents specifying the responsibilities of each participant, as well as the flow of funds. If the bonds for a facility of this type are secured only by the project's revenue, they will command a higher interest rate.
- Lease Revenue Bonds. In this type of financing, public entity or a specially formed non-profit corporation issues tax-exempt revenue bonds to finance a waste management facility. The facility is then leased to the City. Security for the bonds is provided by the lease between the two entities. In situations when projected revenues or a particular project are too limited or the risks are too high, it may be in the government's best interest to provide financial incentives to the private sector to encourage participation in new business development. When the City government provides financial incentives, it either provides financing directly to the private sector or sacrifices potential tax revenues from the private sector. Tax exempt bonds are one example of a government financial incentive that leads to a potential loss in tax revenues.

Loans/Grants

Ideally, most capital investments should be financed through the use of reserves. Nevertheless, in order to finance major capital investments, municipalities may resort to borrowings from commercial banks, international development banks, and central government banks. In some countries, capital expenditures by local governments are controlled by the central government. Each year, the central government sets a limit on the total capital expenditure that can be made. Projects are submitted to the pertinent agency of the central government for approval. Once approved, the local government can borrow either from a public agency or from the money market.

Several international lending institutions have been involved in financing solid waste management investments in economically developing countries. Some of the most active institutions include The World bank, the Asian Development Bank (ADB), and Japan International Cooperation Agency (JICA). The financings covered replacement and expansion of the solid waste collection fleets, construction of the transfer stations and purchase of transfer trucks, design and construction of sanitary landfills and purchase of landfill equipment, development of composting facilities and others. The majority of the financings of solid waste management projects have been included as part of development bank loans for large urban development projects.

Borrowing for major solid waste management investments may be financed through the project or through general obligation financing. In project financing, the financial viability of the project is compared with the revenues that the project is expected to generate. In general obligation financing, the credit of the local government secures the loan. For both types of financing, if future revenues are in doubt, it may be necessary for the government to secure the loan. Most loans for solid waste investments are project financing.

Donations

Local Government Units (LGUs) often have access to a variety of organizations that can donate funds, human resources, or equipment for environmental protection and solid waste management. The organizations can be either national or international. Some of them are willing to assist in solving a specific problem without any conditions, while others impose rather stringent and sometimes costly conditions. This option is purposely included as one of the last options for financing solid waste services because it has been observed that several ill-advised "donations" in which the donations have been encumbered with conditions such that they eventually become costly investment to the community.

20.4.4. Cost Evaluation and Comparison

A recent Annual Budget was set for P 828,934,000, broken down as follows:

- Personal Services Expenses: P 5,818,000

  Of the total amount allocated under this item, only about 5% was spent because only 28 positions were filled-up. The remaining personnel were hired under Contract of Service.

- Maintenance and other operating expenses: P 821,329,000

  P 600,000,000.00 was allocated for Garbage Hauling Services. The expenses for garbage hauling was computed at P 50,000,000 per month for 12 months for the 5 collection districts (District I, District II-A, District II-B, District III and District IV). The amount was based on the price ceilings under the TOR set by the City Government for bidding purposes. However, the actual expenses in a month's time were lower than the ceiling price due to the imposition of fines and penalties on the Contractors for various shortcomings and deficiencies. The penalties accrue as "savings" for the City and were used for Special Operations.

  P 193,200,000.00 was allocated for the improvements that were undertaken at the Payatas Controlled Dump Facility.

  P 10,464,000.00 was allocated for the salaries of the 155 Contractual Personnel in the Department.

  P 5,050,000.00 was allocated for massive IEC-related programs (signboards, flyers, contest in schools and barangays, conduct of special events, rentals, seminars on SWM and Anti-Pollution, etc.).

  P 5,000,000.00 was allocated for the Incentive Package Program given to barangays for the savings accrued through waste diversion.

  P 3,850,400.00 was allocated for the annual implementation of the Sagip Batis sa QC Project or the Riverways Management Program.

  P 3,565,000.00 for Advertisements on SWM.

  P 200,000.00 was allocated for office equipment and repairs and maintenance of motor vehicles.

- Capital Outlay: P 1,786,328.00

  P 1,386,328.00 was allocated for Other Structures – Massive Information Campaign (house to house IEC – Billboards and Flyers).

  P 400,000.00 was allocated for miscellaneous expenses.

An average of P400, 000.00 a year is earned from penalties paid by Environment Violators. The revenue earned from violators is low because Violators are given the option to render community service rather than pay the fine.

The City has never collected hauling service fees from residential areas.

With the approval of the New Revenue Code, however, fees for the collection of bulky wastes was imposed.

21. Incentive Programs

21.1. Background

Chapter IV Sec. 45 of RA 9003 defines incentives as “Rewards, monetary or otherwise, which shall be provided to individual, private organizations, including non-government organizations, that have undertaken outstanding innovative projects, technologies, processes and techniques or activities in re-use, recycling and reduction” of solid waste. It also stipulates that ‘an incentive scheme is provided for the purpose of encouraging LGUs, enterprises or private entities including NGOs to develop or undertake an effective solid waste management or actively participate in any program geared toward the promotion of re-use, recycling and reduction of solid waste

Fiscal incentives in terms of duty and tax exemption, tax credit from capital equipment, tax and duty exemption on donations, legacies and gifts to LGUs are also stipulated in the Act.

Quezon City has developed its own incentive program in order to encourage a wider participation among its stakeholders

21.2. Source Separation and Recycling

The City provided incentives in the form of search contests for model schools and barangays in waste segregation and processing. Schools are considered to be one of the major waste generators in the community with a large potential for waste reduction. Schools provide ideal sites for students to practice the concepts of ecological solid waste management that they learned from the classrooms. By providing adequate motivation, schools can significantly reduce their waste generation which will significantly help in the overall management of wastes in the City.

21.3. Treatment Technologies

In this aspect, no incentive has been provided but the city is actively investigating WTE options.

21.4. Incentives for General Public

The following incentives to the general public as well as among its Barangays have been developed by the city in order to encourage them to actively participate in its solid waste management programs:

- Award of recognition to people, groups, or institutions with outstanding achievements in solid waste management;
- Provision of financial and logistical assistance by the City Government to barangays that meet basic requirements such as having an approved barangay SWM Ordinance, an active SWM committee, functional MRF, and willingness to put up counterpart contributions for waste management projects;
- SWM enforcers to be entitled to a percentage from collected fines from violators of City & barangay solid waste ordinances.

21.5. Incentives for Municipalities

As stipulated in RA 9003, fiscal incentives shall be given to municipalities according to the provisions of the Omnibus Investments Code (E.O.226) such as the granting of tax and duty exemption on imported capital equipment and vehicles within ten (10) years of effectivity of the Act (or until January 2010), provided that it complies to the conditions set forth in the law. These conditions apply to equipment and vehicles not manufactured locally in sufficient quality, are needed for SWM purposes only and DTI-BOI approved. The same exemption applies to domestic capital equipment at 50% tax credit equivalent. Also, tax and duty exemption of donations, legacies and gift to LGUs for the support and maintenance of the program for effective solid wastes management.

Also, those LGUs with SWM plans that have been duly approved by NWSMC or have been commended for adopting innovative SWM programs may receive grants to develop their technical capacities.

Also, those LGUs with SWM plans that have been duly approved by NWSMC or have been commended for adopting innovative SWM programs may receive grants to develop their technical capacities.

21.6. Incentives for Private Sector

For private sector, as stipulated in RA 9003, similar to the local government units (LGUs), fiscal incentives in the form of Tax credit on domestic capital equipment, until January 2010, a tax credit equivalent to 50% of the value of the national internal revenue taxes and customs duties that would have been waived on the machinery, equipment, vehicle and spare parts, had these items been imported shall be given to enterprises, private entities, including NGOs, subject to the same conditions and prohibition cited.

Also, Tax and Duty Exemption of Donations, Legacies and Gift – All legacies, gifts and donations to, enterprises or private entities, including NGOs, for the support and maintenance of the program for effective solid waste management shall be exempt from all internal revenue taxes and customs duties, and shall be deductible in full from the gross income of the donor for income tax purposes.

Enterprises or private entities availing of tax incentives under the Act shall also be entitled to applicable non-fiscal incentives provided for under E.O. 226, otherwise known as the (Omnibus Investments Code).

Further, as stipulated in the Act, the National Solid Waste Management Commission shall provide incentives to businesses and industries that are engaged in the recycling of wastes and which are registered with the Commission and have been issued ECCs in accordance with the guidelines established by the Commission. Such incentives shall include simplified procedures for the importation of equipment and spare parts.

Also, a Financial Assistance Program from government financial institutions such as the Development Bank of the Philippines (DBP), Landbank of the Philippines (LBP), Government Service Insurance System (GSIS), and other government institutions providing financial services gives high priority to extend financial services to individuals, enterprises, or private entities engaged in solid waste management.

Under The BOT Law (RA 6957 as amended by RA 7718) up to 40% foreign equity is allowed in a project proponent and facility operator of a BOT Project requiring a public utilities franchise. Projects involving the generation or transmission, but not distribution, of electricity may be 100% foreign-owned.

Under the BOT Law, project proponents are eligible for fiscal incentives as provided under the Omnibus Investments Code. Local government units may also provide for additional tax incentives, exemptions or relief. The Government may also provide any form of direct or indirect support or contribution, such as, but not limited to, cost sharing, credit enhancements, direct government subsidy, or government equity.

22. Evaluation and Diagnosis

22.1. Background

The monitoring and evaluation of the solid waste management program include detailed recording and assessments of the day-to-day operations. It is important to consider all costs incurred, and what category they fall in to. This is important to assess where resources need to be allocated, or conversely, where program changes might be able to reduce costs.

Secondly, both qualitative and quantitative evaluations of the working of the system need to be made. The assessment of the success of the ISWMP depends upon records of the amount of solid waste collected, frequency of collections of both secondary and primary secondary waste points, cleanliness of the various parts of the systems, and general effectiveness of the program.

Monitoring and Evaluation spreadsheets required would include as a minimum:

- Monthly Landfill Operations: Costs and Evaluation
- Monthly Secondary System: Costs and Evaluation
- Monthly Primary Collection: Costs and Evaluation
- Monthly Primary Storage: Costs and Evaluation

The costs and evaluations information needs to be recorded on a daily basis and turned in to the MSW manager on a weekly basis. The manager should summarize the monthly information and prepare a report to the Mayor on a monthly basis.

More details are provided in **Appendix M – Evaluation and Diagnosis**

The process of ISWM action plan implementation must be monitored and regularly reviewed in order to identify weaknesses in the program and to identify actions to update the process. The following sections discusses this aspect of plan evaluation using indicators and measures of ISWM performance and with reference to specific worked examples of implementation monitoring.

22.2. Performance Monitoring For Solid Waste Management Services

Throughout this Plan the need for collecting and utilising information has been stressed. Large amounts of data are being collected and processed into useable information. But it has to be kept in mind that information *per se* is only valuable when it is focused and being used to a specific end. **Figure 22-1** below shows the various possible uses of information.

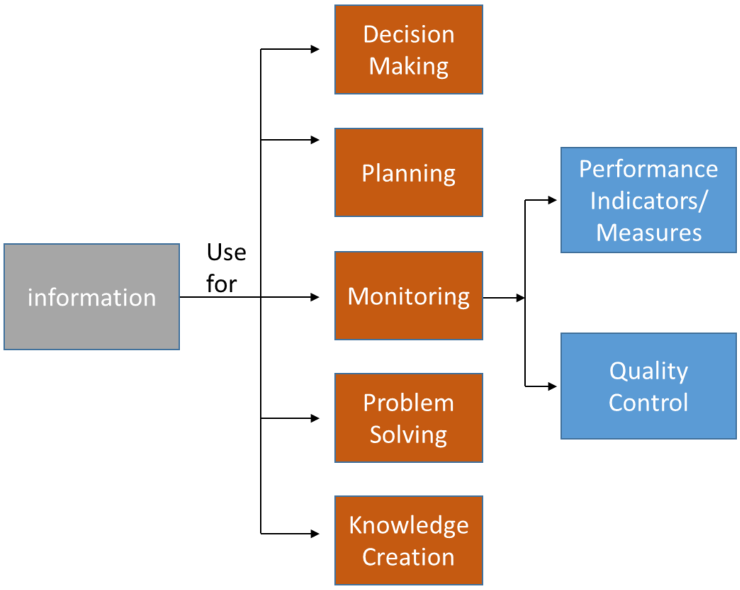


Figure 22-1 Use of Information

22.2.1. Why Improve Performance Monitoring?

The monitoring tools frequently used to assess performance of the ISWM system are, among others,

- visual observations;
- general feed-back from the work force; or
- customer complaints.

Such observations can lead to inaccurate and unquantifiable results and present an insufficient basis for making planning decision for system improvement. Additionally, at first sight seemingly obvious reasons for an unsatisfactory performance of a ISWM function, may, through a more detailed and formal analysis, turn out to not be the reasons at all for the problems.

Monitoring the performance of a municipal ISWM system has a number of goals:

- To closely observe the quality of the ISWM service provided in order to maintain or improve service quality;
- To encourage the efficient use of available resources;
- To relate the outputs of a service to inputs (and ultimately their cost);
- To improve service quality overall and relative to cost;
- To enforce accountability of service providers;
- To put downward pressure on cost of service provision;
- To compare and assess services provided against the targets set out in municipal ISWM plan;
- To provide information on which management can make policy and management decision about the service;
- To compare the service provided between two or more sub-municipalities or municipalities in a regional association;

- To compare the quality of service provision in a City with a previous month or year;
- To monitor and evaluate the quality of services provided by private service contractors.

The two central questions of ISWM performance monitoring are:

1) How effective is the ISWM service that is being provided? Meaning: To what extend does the system presently in place satisfy the need for a ISWM service and where is improvement required?
2) How efficient is the ISWM service provided? Meaning: Are we using the available resources in the best possible way and how can we improve their use?

Effectiveness and efficiency are closely related, increases in efficiency lead in most scenarios to increases in effectiveness, provided resources are not cut simultaneously.

22.2.2. Definitions of Performance Indicators and Measures

In order to determine the performance of a municipal solid waste management system in general, and its individual components in specific, data and information called "performance indicators" and "performance measures" of ISWM are used.

Table 22-1 Performance indicators and measures

Performance Indicators – are quantitative data related to ISWM services such as:

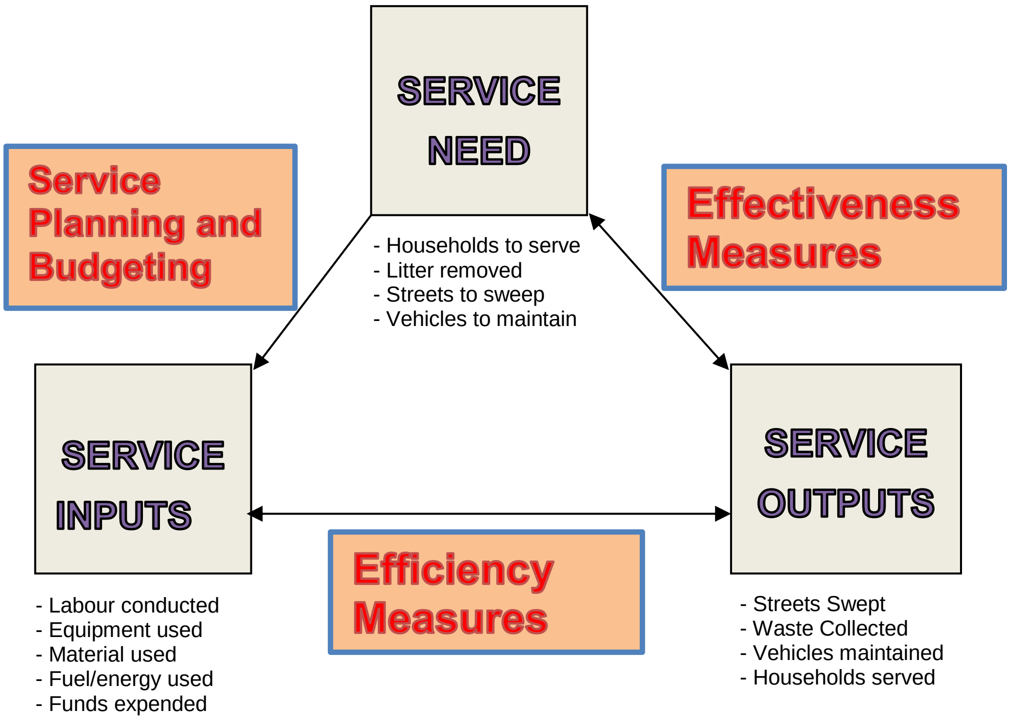
- Number of businesses to be served,
- Kilometres of streets to collect from, or
- Number of employees in service.

Performance Measures – are the result of processing indicators, by relating them to either time or cost, and are the principle tool for assessing the performance of the system under review. For example:

- Cost per ton disposed;
- Number of streets swept per hour etc.

In order to obtain reliable performance measures, the following is needed:

- Accurate, reliable and regular data collection;
- Accurate and reliable cost accounting procedures;
- Weighing of wastes, or estimates based on waste volumes as a substitute;
- Availability of service operating detail;
- Units to which the performance indicators can be related (e.g. costs per 1000 of population served, costs per household served, time per tonne of waste collected etc.)



- Figure 22-2 Indicators and Performance Measures

22.3. Revising and Updating the ISWM Plan

The process of ISWM plan review should be regularly undertaken in a planned and scheduled fashion. A regular review of the progress with implementation of the action program is necessary to ensure that targets are being met in terms of service delivery, financial performance et.

The action plan needs to be flexible and there may be a need for the implementation program to adapt to changing circumstances and conditions, such as, for example, changes in the waste stream (e.g. through increased affluence), development of new technologies to treat and dispose of waste, or institutional changes.

A program of regular review can help to increase the City's knowledge and understanding of the ISWM system through a process of interactive review, problem diagnosis and development of remedial action programs.

22.4. Current Evaluation and Diagnosis Program

QC presently implements SWM performance and implementation monitoring as described below. This could be expanded in accordance with the options listed above but remains a very suitable program at this stage in any case.

The following monitoring programs are implemented to ensure that all the projects and activities are being implemented in accordance with this Plan.

22.4.1. Regular Board Meeting of the City Solid Waste Management Board

The Board will convene once a month to discuss the implementation and development of the solid waste management plan. The board must see to it that all the projects and activities are implemented as scheduled. A monitoring chart of activities will be devised which will serve as a guide for the implementation of the plan.

22.4.2. Monitoring of the MRF Projects in the Barangay.

All the MRF Projects in pilot barangays will be monitored by the EPWMD at least once a month to ensure that the projects are sustained. A monitoring form will be devised to keep track of the system especially the data of the waste diverted through recycling and composting activities.

22.4.3. Monitoring of the Waste Segregation Compliance by the Stakeholders

In connection with the IEC programs, surveys will be conducted to all sectors to monitor the compliance of the stakeholders with regards to the segregation and storage of wastes. A survey form will be devised for the purpose. Information and data that will be gathered through these surveys will serve as the bases for future planning and operation.

22.4.4. Monitoring of the Collection and Transport of Wastes.

The monitoring of the collection and transport of waste will be in accordance with the existing monitoring activities being undertaken by the City. However, the present system can still be improved to cope with the developments in solid waste management as a whole.

The Work Assignment Ticket (WAT) contains information to properly monitor the collection, transport and disposal of waste. This ticket involves the barangay officials in the monitoring activities since certification is being made if collection of wastes in their area is properly done or not. This ticket also serves as the basis for the payment of bills to the contracted private haulers.

Mobile monitors are implemented to ensure the proper collection of waste by the private haulers, area monitors on motorcycles will be deployed to check if the area covered by the collection is clean and garbage –free. Penalties are charged against the Contractors if the area is found to be dirty and/or uncollected of garbage.

In addition to the existing monitoring system in the collection and transport of waste, the Work Assignment Ticket being used will be modified further to monitor the segregated collection system. As such, the barangay officials and the Mobile Monitors shall see to it that segregated collections are being strictly implemented and followed.

22.4.5. Monitoring of the Quantity of Waste Collected.

For an accurate monitoring of the quantity of waste, the City will provide a weigh bridge scale which will be used to weigh the amount of waste collected by each truck before the processing of waste will take place. The system will enable the City to acquire an accurate baseline data on the quantity of waste in a given period. The system will also provide information of the waste generation of each sector or source of the collected waste. The data will be added in the work assignment ticket for easy monitoring.

22.4.6. Monitoring of processed wastes.

The person-in-charge of the processing facility shall be required to submit to the board and to EPWD a regular monitoring report which shall contain the following information:

- Quantity of raw biodegradable waste
- Quantity of compost produced
- Quantity of recyclable materials per classification
- Sales of recyclable materials and compost

- Quantity of residual wastes
- Operational Expenses

22.4.7. Monitoring of the Disposal of Waste and of the Disposal Facility

A weigh bridge will also be provided at the disposal facility to quantify the amount of waste disposed. The person in-charge of the disposal facility shall be required to submit to the Board and to the EPWMD a regular monitoring report which shall contain the following information:

- Quantity of incoming waste to the facility
- Existing conditions of the facility
- Operational expenses
- Basic recording data

22.4.8. Technology Based Monitoring Centre

A CCTV system will be installed in despatch centres to allow EPWMD staff to remotely monitor vehicle movements.

23. SWM Plan Summary Output

The outputs from the Solid Waste Management planning exercise are summarized as below:

The implementation of this plan will be divided into three (3) phases, to wit:

23.1. Phase 1 (year 1-Year 3)

- Convene the City SWM Board to be a Working Committee
- Establish barangay based MRFs
- Conversion of Payatas Open Dump
- New Disposal site scouting and selection
- Implement financing reserves for SWM projects
- Implement IECs
- Collection
    - Modification/adjustment of cell collection areas
    - Strict implementation of no segregation no collection scheme
    - Strict implementation of dedicated collection
- Alternative waste diversion options

  The City will consider other options for the diversion of waste materials from disposal other than the MRF projects. In case the turn-out of the waste diversion in the MRF projects will be low, or in case this project will not materialize, other systems and technologies will be adopted such as:
    - Pyrolysis
    - Incineration as part of a WtE facility
    - Plasma Conversion Technology
    - Auto Clave (for health care wastes)
    - Sterilization (for health care wastes)
    - Hydromex
    - Other technologies which could be used to properly process biodegradable, recyclable and residual wastes which may either be developed by the private sector or the government through the Department Of Science and Technology (DOST).
- Transport and Disposal
    - Proper documentation of waste volume
    - Establishment of composting facility for Q.C. possibly
    - Continuous upgrading and modification of the disposal system

23.2. Phase 2 (Year 4 – Year 6)

- Closure and rehabilitation of Payatas Controlled Dump
- Post Closure Plan Implementation

23.3. Phase 3 (Year 7 – Year 10)

- New disposal site determination and acquisition
- Development of a sanitary landfill at the Payatas area
- Processing of incentive claims on waste reduction initiatives
- Implement alternative disposal for special wastes

23.4. Milestones

The following are the highlights of the plan's implementation:

- The Board is the decision making body in the implementation of the City's Solid Waste Management Plan. Hence, they will review and decide its final context.
- Specific plans and projects that need the approval of the general public (public hearings).
- Financing capital investments for the City's Solid Waste Management Projects.
- Massive IECs using tri-media
- Start of segregated/dedicated collection
- Design and approval of SLF for Quezon City
- Construction of SLF for Q.C.
- Design and Construction of a large scale MRF for Q.C.

23.5. Implementation Schedule

In addition to the dates specified in this plan, the board shall meet to discuss other specific dates for the implementation of this plan.

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Appendix A - Glossary of Terms

Aerobic process. Biological treatment process that occurs in the presence of oxygen. Certain bacteria that can survive only in the presence of any dissolved oxygen are known as obligate anaerobes.

Anaerobic process. Biological treatment process that occur in the absence of oxygen. Bacteria that can survive only in the absence of any dissolved oxygen are known as obligate anaerobes.

Amenity. The current existence of healthy, pleasant and agreeable (community) surrounding.

Aquifer. A saturated permeable geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients.

Avoidance/reduction. Reducing the quantity of waste produced and the quantity of resources consumed during the manufacture and life-time of the product.

Batch. Samples taken from one site in one day.

Beneficial use. The environmentally benign and useful application or use of a resource which is of public benefit, including welfare, safety, health and aesthetic enjoyment.

Bioremediation. The remediation or decontamination of any contaminated matter by the use of processes involving biological organisms.

Biosolids. The particulate matter, mainly organic, removed during the treatment of sewage.

Building and demolition waste. Solid and inert waste materials, arising from the demolition, erection, construction, refurbishment and alteration of buildings and construction, repair and alteration of infrastructure including roads, bridges, dams, tunnels, railways and airports.

Buffer distance. The distance between the tipping area of a landfill site and a segment of the environment to be protected.

Cell. A section of a landfill.

Clean excavated natural material. Material consisting of clay, soil and crushed rock which is not contaminated or mixed with any other material.

Clinical waste - (also called Medical waste). Any cytotoxic or contaminated solid waste which includes:

- **Sharps:** Any object capable of inflicting a penetrating injury contaminated with blood and/or body fluids. This includes needles, needle or syringe combinations and any other sharp objects or instruments designed to perform invasive procedures.
- **Bulk body fluids, blood and blood products**: Including any vessel, bag or tubing containing body fluids, blood or blood products.
- **Disposable and dressings linen:** Heavily soiled with blood and/or body fluid.
- **Microbiological and pathological waste:** Including discarded laboratory specimens, cultures and materials that have contact with such, and biological reagents.
- **Tissue:** Human tissue, organs, body parts, placentas and products of autopsy and animal tissue.

Commercial and industrial waste. Solid and inert waste generated by businesses and industries (including shopping centres, restaurants and offices) and institutions (such as schools, hospitals and government offices), excluding building and demolition waste and municipal waste.

Composting. The process of the conversion of organic materials by micro-organisms into soil conditioners, compost or humus. By definition, it is a process which must be carried out under controlled conditions yielding cured products.

Construction waste - see Building and demolition waste

Cover material. Approved material for use to cover dumped waste at landfills.

Decomposition. The breakdown of organic waste material by micro-organisms.

Degradation. An environmentally significant natural, physical, chemical or biological transformation to a lower state.

Demolition waste - see Building and Demolition waste.

DENR. Dept of Environment and Natural Resources

EMB. Environment Management Bureau

EIS. Environmental Impact Statement.

EMP. Environmental Management Plan

EPWMD. Environment Protection and Waste Management Department

GFI. Government Financial Institution

Greenhouse Gases. Gases, such as methane and carbon dioxide, which in turn contribute to global warming.

Groundwater. Water saturating the voids in soil and rock; water in the zone of saturation in the Earth's crust.

Hazardous Waste. Waste which, through toxicity, carcinogenicity, mutagenicity, flammability, explosivity, chemical reactivity, corrosivity, infectiousness or order biologically damaging properties, which may present danger to the life or health of living organisms when released into the environment, excluding:

- municipal waste (other than chemical waste specially collected); and
- legal discharge to sewer, subject to trade waste or customer contract.

HHW. Household Hazardous Waste

IEE. Initial Environmental Examination

Industrial waste - see Commercial waste

Inert waste. Wastes which do not undergo environmentally significant physical, chemical or biological transformation and have no potentially hazardous content once landfilled. This waste from building and demolition includes bricks, concrete, glass, plastics, metal and timber. They must not be contaminated or mixed with any other material.

Inert waste landfill. Any landfill that accepts only inert wastes (*see* definition above). Inert waste landfills are usually subdivided into two class:

- **Class 1** - all inert waste including stabilised asbestos cement and physically, chemically or biologically fixed, treated or processed waste.

– **Class 2** - all inert waste except stabilised asbestos cement or physically, chemically or biologically fixed, treated or processed waste.

Landfill Environmental Management Plan (LEMP). A detailed plan for the operations of a landfill site from a greenfield state to a fully rehabilitated state including after-care.

Landfill gas. Gaseous emissions from the decomposition of waste. Also called biogas.

Landfill site. A waste facility used for the purposes of disposing of waste to land.

Leachate. Liquid released by, or water that has percolated through, waste and which contains dissolved and/or suspended liquids and/or solids and/or gases.

City. Local Government Unit

Litter. Solid waste that is outside the tipping area of the landfill site and is not part of the formal waste collection system.

Material recovery. A form of resource recovery of wastes otherwise destined for disposal in which the emphasis is on separating and processing waste materials.

Medical waste - see Clinical and related waste and Contaminated waste

Methane (CH_4). An explosive, odourless and colourless gas produced in a landfill by organic waste undergoing anaerobic decomposition. It is lighter than air.

MRF. Materials Recovery Facility

Mulching. The size-reduction of organic materials using one or more of the following processes: cutting, milling, shredding, grinding and other means.

Municipal waste. Solid and inert wastes arising from the three waste sub-streams:

– **Domestic waste** - household solid and inert wastes placed out for kerbside collection

– **Other domestic waste** - residential solid and inert wastes arising from domestic clean-up and garden waste

– **Other City waste –** municipal generated solid and inert wastes arising from street sweepings, litter bins, parks and garden clean-ups, tree loggings and council engineering work.

NSWMC. National Solid Waste Management Commission

Organic waste. One or more of the following types of waste: garden, untreated wood, fibrous, vegetables, fruits, cereals, biosolids, manures, fatty foods, meat, fish and fatty sludges.

PMO. Project Management Office

Poorly stabilised material. A treated material which is prone to further degradation or decomposition.

Public authority. A public or local authority constituted by or under an Act and includes:

– a Waste Board, or

– a department of the public sector, or

– a member of staff or other person who exercises functions on behalf of a public authority , or

– a nationally owned corporation or a subsidiary of such a corporation.

Putrescible waste. Waste being food or animal matter (including dead animals or animal parts), or unstable or untreated biosolids.

Recycling. The process by which waste otherwise destined for disposal is collected, reprocessed or re-manufactured and used to make a product.

Remediation. Work for the remediation, rehabilitation and monitoring of premises the subject of a licence and that is required by the conditions of a licence to be carried out:

- While the premises are being used for the purpose to which the licence relates, or
- after the premises cease being used for the purpose to which the licence relates, or both.

Reprocessing. Physical, chemical and biological processing used to transform waste, otherwise destined for disposal, into a raw material used to make a product.

Resource recovery. The extraction and utilisation of materials from mixed waste. Material recovered can be used in the manufacture of new products. Recovery of value includes energy by utilising components of waste as a fuel, production of compost using solid waste a medium, and reclamation of land.

Re-use. A process by which waste otherwise destined for disposal is cleaned or repaired for use, for the purposes of prolonging the original product lifetime prior to treatment or reprocessing.

Run-off. The portion of precipitation that drains from an area as surface flow.

Run-on. Where surface water runs off one site and flows onto the site in question (i.e. the landfill site).

Sludge. Semi-liquid waste produced as a by-product of an industrial process.

Solid waste. Any non-hazardous, solid, degradable waste. This includes putrescible wastes; garden wastes; uncontaminated biosolids; and clinical and related waste. All solid waste will have an angle of repose of greater than five degree (5^0) and have no free liquids.

Stabilised material. Material not prone to further degradation or decomposition.

Surface water. Surface water includes all natural and constructed waterways or channels whether flow is intermittent or not; all lakes and impoundments (except lined dams associated with landfilling activities); and other marshes, lagoons and swamps.

SWM. Solid Waste Management

SWMB. Solid Waste Management Committee

SWMP. Solid Waste Management Plan

Toxins. Substances which are harmful to humans, animals or plants.

TS. - *Transfer station*. A waste facility used to transfer waste from collection vehicles to a bulk haul vehicle, generally in order to achieve long distance transportation efficiency.

Treatment. Physical, chemical or biological processing of a waste for disposal.

Waste. Waste includes:

- any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such a volume, constituency or manner as to cause an alteration in the environment, or
- any discarded, rejected, unwanted, surplus or abandoned substance, or
- any otherwise discarded, rejected, unwanted surplus, or abandoned substance intended for sale or for recycling, reprocessing, recovery or purification by a separate operation from that which produced the substance, or
- any substance prescribed by the regulation to be waste for the purposes of this Act.
- A substance is not precluded from being waste merely because it can be reprocessed, re-used or recycled.

Waste facility. Any premises used for the storage, treatment, reprocessing, sorting or disposal of waste.

Water table. The top level of groundwater lenses

Appendix B – Quezon City Current 10-Year Solid Waste Development Plan.

EXECUTIVE SUMMARY

In 1999, Quezon City got the Kalabasa Award for being the dirtiest city in Metro Manila. The disparagement was richly deserved as anyone living in the City at that time would attest.

The "per trip" system of paying garbage contractors virtually guaranteed corruption. Garbage contractors were paid for every trip their trucks made. Uncollected garbage was a boon- an excuse for the contractors to make more money. As a result, week-old garbage lay rotting in front of homes, on street corners, or wherever people congregated. Residents, fearing infestation, or perhaps just tired of having garbage pile up in their backyards, dumped it on the river or anywhere when nobody was looking. Quezon City was headed for the dumps. And yet, just a few years later, the City was able to completely transform itself.

The 10-Year Solid Waste Development Plan covers all sectors and addresses problems especially in the enforcement of environmental laws. The thrust of the Plan is waste reduction/diversion through recycling and composting activities in the Barangay level. Waste reduction/diversion will be focused on the residential areas because they contribute the bulk of solid waste generated. The City shall require all Barangays or cluster of barangays to put up their own Eco-Centers/MRF. The Waste Management Committee shall also be formed and activated in every Barangay. The Committee may form Cooperatives for the program to be self-sustaining. Incentives and awards program shall also be part of the plan to encourage the Barangays to perform well.

Apart from the above, the City has made several breakthroughs in waste management:

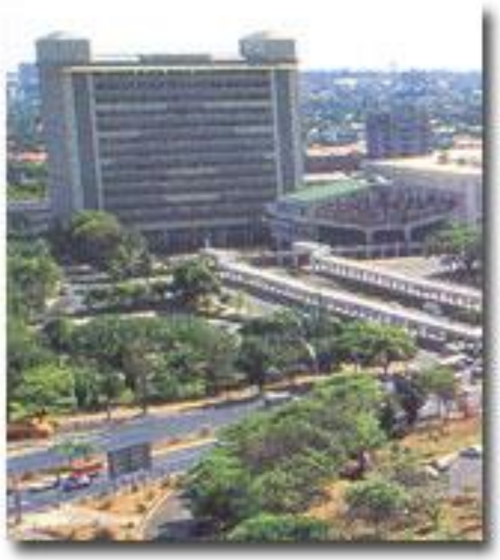
- Quezon City was the FIRST URBAN CENTER TO IMPLEMENT REPUBLIC ACT 9003 by converting the Payats Open Dump into a Controlled Waste Disposal Facility (CDF).
- Quezon City was the FIRST TO IMPLEMENT A CLEAN-UP CITY CONCEPT OF WASTE MANAGEMENT in the country, such system replacing the notorious "Per Trip" arrangement.
- Quezon City RECEIVED THE HIGHEST NUMBER OF NOMINATIONS AMONG ALL THE CITIES IN THE COUNTRY IN 2004 National Search for Model Barangay for Eco-Waste management System. One of its barangays, Holy Spirit, took the Bronze award, besting over 200 candidates.
- Quezon City's "No Segregation, No Collection" policy in some pilot barangays resulted in a significant reduction (11.45%) of waste volume intake at the Payatas CDF as well as helped the City divert a sizeable amount of solid waste more than the percentage diversion required by law.
- Quezon City has a GARBAGE COLLECTION EFFICIENCY OF 99.77%. This translates to savings in collection costs of over PhP2.5 million a month, or about PhP30 million a year.
- Quezon City BUILT THE COUNTRY'S FIRST METHANE GAS EXTRACTION FACILITY, turning garbage gas from Payatas into electrical power.

Further, the "Biogas Emission Reduction Project" of the Quezon City local government is the latest project issued with a letter of approval by the Department of Environment and Natural Resources (DENR). The project has demonstrated its environmental, social and economic benefits through the extraction and conversion of methane gas to energy. By effectively utilizing the methane gas from the decomposition of organic materials, it will help reduce greenhouse gas emissions, thus addressing global *and regional impacts of climate change. The Biogas Emission Reduction Project of Quezon City will run for 10 years. During that time, it is expected to reduce an average annual reduction of about 116,339.4 tons of carbon dioxide emission.*

The project involves two phases. The first phase will be composed of a methane extraction system, a high-temperature torch for flaring the methane extracted and an electrical engine for on-site power supply. The second phase, on the other hand, will begin on the third year, wherein the project will convert a portion of the methane generated to electricity that will be delivered to surrounding communities in the area. The Clean Development Mechanism (CDM) is a market-based mechanism provided under the Kyoto Protocol, an international agreement designed to assist developing countries such as the Philippines implement projects that reduce greenhouse gas emissions.

Waste management has been a priority concern from day one of Mayor Belmonte's administration and efforts in that direction are visible. With the initiatives of the Quezon City government, the objectives of the Mayor to make the city Dynamic, Productive, Healthy, Nurturing and caring, Safe and Secure, Environment Friendly, and Well-governed will very soon be a reality.

I. INTRODUCTION



Feliciano "Sonny" Belmonte, Jr. assumed the leadership of the Quezon City government on July 1, 2001. Instituting effective governance has been the focus of his administration from his first day in office. His thrust is to make the City competitive in terms of its ability to:

- *Manage and deliver its services to the people;*
- *Promote the growth and flow of commerce within the City through process and infrastructure improvements, and through better traffic management;*
- *Encourage and obtain the support of his constituents in its programs and projects through greater government-public sector collaboration.*

His guiding principle is to make the Quezon City government a model of effective governance and responsible leadership to hasten the City's development into a Quality Community that is:

- *Dynamic*
- *Productive*
- *Healthy*
- *Nurturing and caring*
- *Safe and secure*
- *Environment-friendly*
- *Well-governed.*

To oversee the protection of the environment, the Environmental Protection and Waste Management Department (EPWMD) was created. It was organized during the early part of the administration of Mayor Feliciano Belmonte, Jr. as an improved version of the Task Force Clean and Green of the previous city administration. The EPWM Department is mandated to:

- ✓ Enforce all laws, regulations and policies pertinent to environmental management and pollution control;
- ✓ Design and maintain a waste collection and disposal system conforming to the requirements of RA 7160, 8749 and 9003; and
- ✓ Implement an awareness plan in support of its environmental and waste management programs.

Its corollary functions are to:

- Maintain a comprehensive pollution control program, including anti-smoke belching and industrial pollution control;
- Undertake continuing research on current environmental management technologies; and
- Establish operational linkages with other local and national agencies concerned with environmental protection and waste management.

Solid waste management is one of the city's major thrusts. This is attributed to two (2) important factors:

First, increase in the volume of solid waste has become inevitable in the past years, given the increasing socio-economic development and the rate of urbanization experienced by the City; and,

Second, the enactment of Republic Act 9003, otherwise known as the Ecological Solid Waste Management Act of 2000, has institutionalized solid waste management as a *primary agenda, setting mandatory provisions that have to be implemented by all local government units.*

One of the stipulations in RA 9003 under Section 16, provides that all Local Government Units (LGUs) must come up with their respective ten-year solid waste management plan in accordance with the National Framework and pursuant to the provisions of the said Act. Given this mandate and the thrust of the City Government on proper solid waste management, a 10-Year Solid Waste Management Plan was drafted with the end view of providing efficient, cost-effective and ecologically managed services in the next ten (10) years. The thrust of the Plan shall be the identification of implementable strategies and activities that encourage re-use, recycling and composting of wastes generated.

1.1 Purpose

In summary, the 10-Year Solid Waste Management Plan of Quezon City envisions to achieve the following:

a) *A model city where all of its barangays are practicing waste segregation at source and segregated collection;*

b) *A city and barangays with a facility where solid wastes are processed and converted to other useable resources;*

c) *A city where solid waste avoidance and volume reduction is commonly practiced by the general public;*

d) *A city where only residual waste are being collected by the City contracted waste haulers; and,*

e) A city where residents and transients comply with environmental laws and policies.

Aside from complying with the provisions of the law, it is hoped that in attaining the aforementioned targets, the City will be able to eliminate the potential risks brought by unmanaged solid waste on the health and safety of the people as well as on the environment.

1.2 Approach

In coming-up with the 10-Year Solid Waste Management Plan of Quezon City, the following processes and activities were undertaken:

Capacity Building. In order to be equipped with the necessary skills and knowledge in preparing the Plan, a series of seminars and workshops were attended by the technical personnel of the EPWMD. In these seminars, the group was able to familiarize themselves with the step-by-step process of preparing the plan as well as its data requirements and prerequisites.

Compilation of existing data. Existing data such as Operational Plans, Annual Accomplishment Reports, etc. were reviewed and evaluated to get the general trend and pattern of the solid waste management system being implemented by the City.

Data Gathering from secondary sources. Collection and review of pertinent data from secondary sources were also done to be aware of the latest technologies in solid waste management. Programs and strategies implemented by other areas were also studied for replication purposes, if deemed relevant to the needs and problems of the City.

Other data sources include the City's Comprehensive Land Use Plan prepared by the City Planning and Development Office (CPDO) as well as demographics from the National Statistics Office (NSO).

Field Work and Analysis of the Existing Situation. *Reconnaissance survey was conducted as a tool in determining the existing solid waste management practices of the City. This was achieved through direct observation of the system employed as well as interviews from the residents on issues pertaining to solid waste management. A preliminary mapping of the direction of the City towards an effective and efficient solid waste management system followed suit using the result of the field work conducted and the data gathered from primary and secondary sources.*

Formulation of the 10-Year Solid Waste Management Plan. *Guided by the provisions set forth in R.A. 9003 and the foregoing analysis of the existing situation, the City's 10-Year Solid Waste Management Plan was drafted.*

II. CITY PROFILE

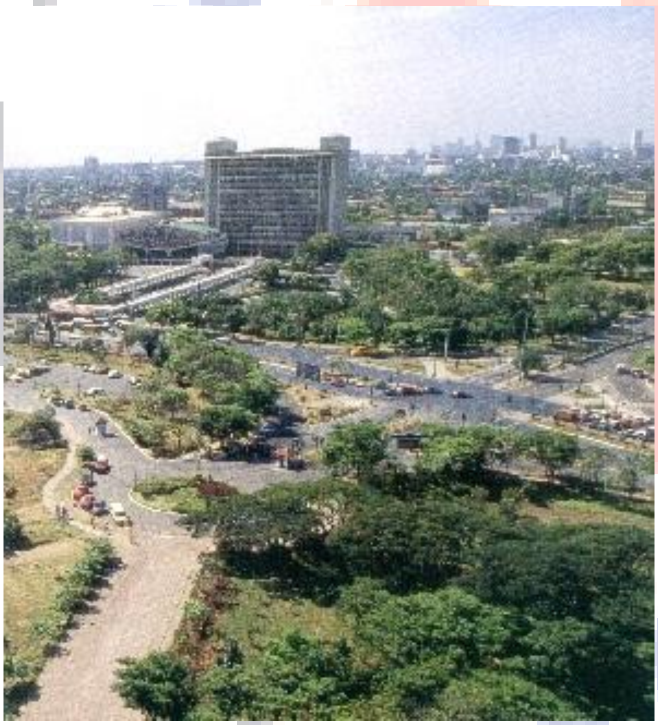
Quezon City, the metropolis born out of President Quezon's vision of a working man's community. It takes pride in being the largest city in Metro Manila, with the expanse bringing hosts of challenges and opportunities. It has proven to be a central location for education, media and training, as well as a hospitable environment for business and industry.

Quezon City is the largest of the sixteen cities and one municipality in Metro Manila. Sprawling over 15,106 hectares, it covers one-fourth of the National Capital Region's land area.

2.1 LOCATION

Quezon City is bounded on the North by Caloocan City and San Jose Del Monte, on the South by Pasig, Mandaluyong and San Juan, on the West by Manila, Caloocan, Valenzuela and on the East by Rodriguez, San Mateo and Marikina City.

This strategic location provides stable ground foundation, adequate surface drainage, deep water table, and ample ground water supply. It is an area of moderate slopes and the most common soil type is the hard loam, more popularly known as the adobe which was heavily used in construction in the past.



In terms of land area, Quezon City is the second biggest in the country, being next in size to Davao City. The City has a total land area of 16,112.12 hectares, which is approximately 29.6% of the 54,344.29 hectare land area of Metro Manila. It has four (4) congressional districts comprising of 142 barangays.

2.2 HISTORY

Quezon City was created on October 12, 1939 by virtue of Commonwealth Act 502. It became the capital of the Philippines with the enactment of Republic Act No. 333 on July 17, 1948. In 1975, Quezon City became part of the larger urban governance scheme that is Metro Manila, with the creation of the Metropolitan Manila Commission by virtue of Presidential Decree

824. On July 24, 1976, then President Ferdinand E, Marcos issued Presidential Decree No. 940, conferring the role of the nation's capital to Metro Manila, hence the name National Capital Region.

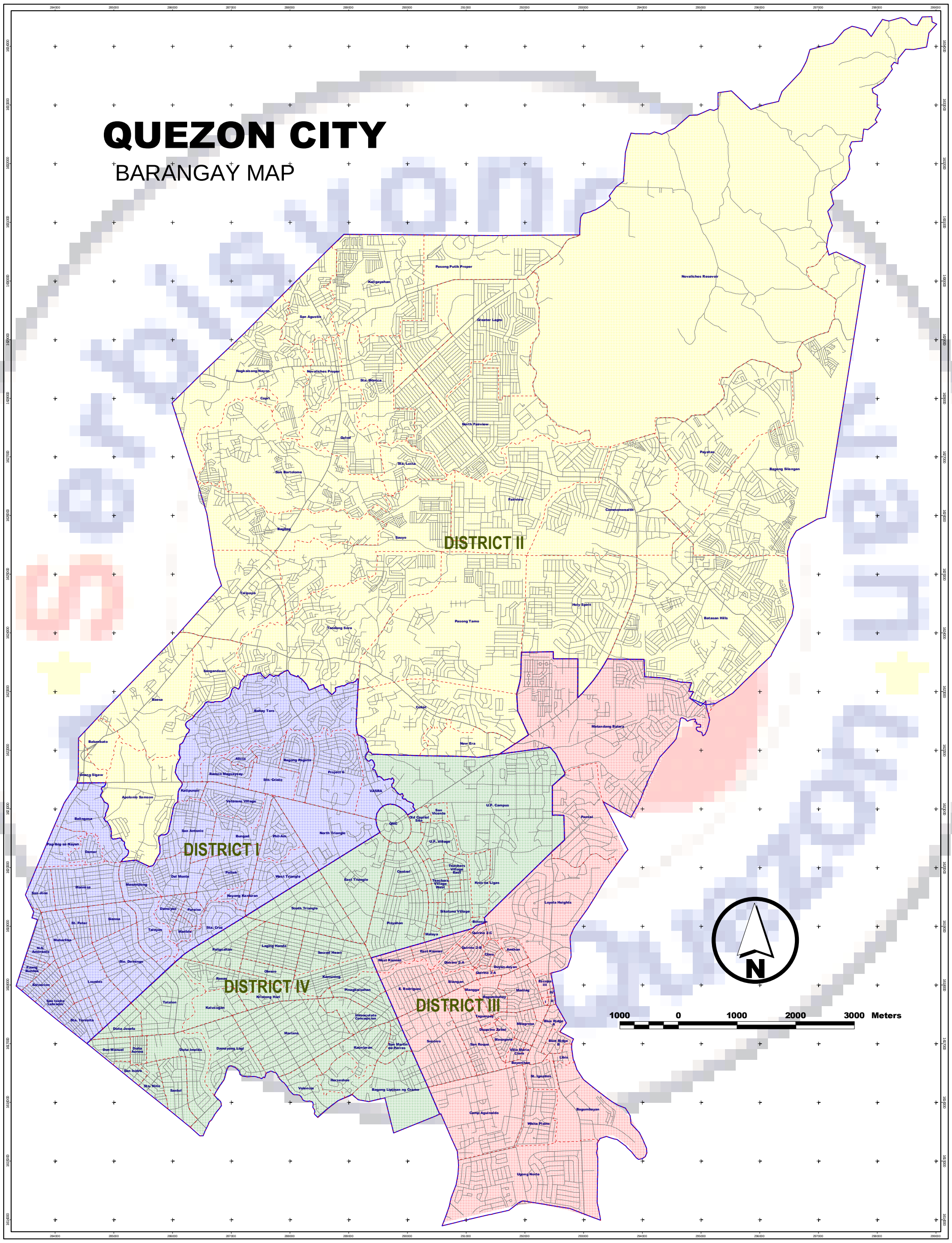
President Quezon himself served as the city's first Mayor and he later appointed Tomas Morato to the position. A long line of distinguished Mayors succeeded Morato in the stewardship of the city as follows: Ponciano Bernardo, Nicanor Roxas, Ignacio Santos Diaz, Norberto Amoranto, Adelina Rodriguez, Brigido Simon, Jr., Ishmael Mathay, Jr. and the incumbent Feliciano Belmonte, Jr,

While relatively a young City, great events that shaped the nation's course of history took place in fabled lands now part of Quezon City territory. The National Centennial Commission, tasked to spearhead appropriate commemoration of 100 years of Philippine Independence, has included Quezon City in the "Freedom Trail" highlighting places and important events in the struggle for freedom and sovereignty, including the historic "Cry of Pugad Lawin" led by the Great Plebeian, revolutionary hero Andres Bonifacio on August 23, 1896, the People Power Revolution in EDSA that toppled the regime of President Ferdinand E. Marcos and the installation of Corazon Aquino, as the 11th President of the Philippines.

Historical Highlights

The following is an inventory of important dates and historical events of the City:

August 23,1896 - Bonifacio and his men tore their cedulas at Pugad Lawin and ignited the Filipino Revolution against the Spain.


QUEZON CITY
BARANGAY MAP
DISTRICT I
DISTRICT II
DISTRICT III
DISTRICT IV
N
1000 0 1000 2000 3000 Meters

October 10, 1938 - The People's Homesite Corp. purchased 1,529 hectares of land from the vast Diliman Estate of the Tuason Family to be the site of the capital city.

September 28, 1939 - The National Assembly approved Bill No. 1206 proposing the creation of Quezon City.

October 12, 1939 - Pres. Quezon signed into law Commonwealth Act No. 502, officially establishing Quezon City, and then assuming the position of Mayor in a concurrent capacity.

November 10,1939 - Tomas Morato was sworn into Office as Mayor of Quezon City.

December 17, 1945 - Pres. Osmena issued Proclamation No.32 launching the nationwide campaign to raise funds for the erection of a national monument in honor of Pres. Quezon.

January 1, 1946 - Ponciano Bernardo was appointed by Pres. Osmena as Mayor of Quezon City

July 17, 1948 - Republic Act No. 333 transferred the territorial jurisdiction of Caloocan City over Baesa, Talipapa, San Bartolome, Pasong Tamo, Novaliches, Banlat, Kabuyao, Pugad Lawin, Bagbag, Pasong Putik to Quezon City.

February 4, 1954 - Pres. Magsaysay formally appointed Norberto S. Amoranto as acting Mayor of Quezon City.

June 16, 1956 - Republic Act 1575 was passed in the third session of the third Congress of the Philippines, amended and repealed certain sections of Quezon City. This law radically changed the geographic composition of the City.

November 30,1972 - The 1971 Constitution Convention was signed in Quezon City.

March 31, 1976 - Adelina Rodriguez won over Norberto S. Amoranto as Mayor of Quezon City.

March 31, 1978 - Pres. Marcos declared 1978 as Manuel L. Quezon Centennial Year.

January 1980 - In the first local elections after martial law, Adelina Rodriguez and Stephen Santo were elected mayor and vice mayor, respectively.

February 22-25,1986 - Quezon City was the site of the EDSA "People Power Revolution."

February 2, 1988 - Brigido Simon Jr., and Vicente Sotto were sworn into office as duly elected mayor and vice mayor, respectively.

October 12, 1989 - Quezon City celebrated its Golden Jubilee.

July 1, 1992 - Ishmael A. Mathay Jr., was elected Mayor with Charito Planas as Vice- Mayor.

May 8, 1995 - The people of Quezon City re-elected Mayor Mathay and Herbert Bautista was elected Vice-Mayor.

May 11, 1998 - Mayor Mathay was again re-elected for his third and final term. His running mate Connie Angeles was elected Vice-Mayor.

July 1, 2001 - Feliciano Belmonte Jr., assumed office as elected Mayor with Herbert Bautista as vice-Mayor.

2.3 DEMOGRAPHY

The people of Quezon City are of mixed regional origin as they are mostly migrants from different parts of the country. The City's population is the largest in Metro Manila with a total of 2,173,831 based on the census conducted by the National Statistics Office (NSO) on May of 2000. The City Planning and Development Office, on the other hand, have estimated the City's population at 2,487,078 in the year 2005.

Tables 1 & 2 shows the City's population and the 10-year projected population at a growth rate of 1.92 % per annum.

Table 1. Total Population Per Barangay

CITY / BARANGAY	TOTAL POPULATION	HOUSEHOLD POPULATION	NO. OF HOUSEHOLDS
QUEZON CITY	**2,173,831**	**2,158,367**	**480,624**
1. Alicia	6,003	5,997	1,273
2. Amihan	4,137	4,127	991
3. Apolonio Samson	28,723	28,723	6,431
4. Aurora	5,170	5,101	1,175
5. Baesa	42,351	41,729	9,165
6. Bagbag	38,799	38,735	8,860
7. Bagumbuhay	6,911	6,911	1,570
8. Bagong Lipunan ng Crame	10,388	10,312	2,509
9. Bagong Pag-asa	39,243	39,243	9,407
10. Bagong Silangan	32,497	32,495	7,312
11. Bagumbayan	7,597	7,597	1,558
12. Bahay Toro	54,118	53,921	11,484
13. Balingasa	19,285	19,285	4,221
14. Bayanihan	1,196	1,196	282
15. Blue Ridge A	1,674	1,674	300
16. Blue Ridge B	1,345	1,345	239
17. Botocan	7,402	7,384	1,596
18. Bungad	10,180	10,162	2,197
19. Camp Aguinaldo	4,383	4,383	819
20. Central	11,998	11,998	3,165
21. Claro	3,950	3,950	935
22. Commonwealth	120,569	119,054	26,060
23. Batasan Hills	109,723	107,818	23,905

CITY / BARANGAY		TOTAL POPULATION	HOUSEHOLD POPULATION	NO. OF HOUSEHOLDS
24.	Kristong Hari	3,542	3,509	788
25.	Culiat	49,639	49,541	10,824
26.	Damar	1,651	1,651	329
27.	Damayan	8,758	8,758	1,936
28.	Damayang Lagi	16,760	16,750	3,931
29.	Del Monte	12,971	12,511	2,683
30.	Dioquino Zobel	1,876	1,876	447
31.	Dona Imelda	15,714	15,636	3,635
32.	Dona Josefa	2,373	2,372	565
33.	Don Manuel	3,279	3,269	848
34.	Duyan – Duyan	2,735	2,735	659
35.	E. Rodriguez	16,974	16,916	3,875
36.	East Kamias	6,423	6,423	1,549
37.	Escopa 1	2,050	2,050	472
38.	Escopa 2	2,060	2,060	443
39.	Escopa 3	7,569	7,503	1,555
40.	Escopa 4	1,710	1,610	346
41.	Fairview	30,332	30,007	6,315
42.	N.S. Amoranto (Gintong Silahis)	6,686	6,678	1,631
43.	Gulod	46,706	46,701	10,125
44.	Horseshoe	2,817	2,776	579
45.	Immaculate Concepcion	9,172	8,954	2,025
46.	Kaligayahan	29,588	29,518	6,503
47.	Kalusugan	2,279	2,092	519
48.	Kamuning	14,516	13,646	3,062
49.	Katipunan	1,959	1,959	433
50.	Kaunlaran	8,222	7,933	1,747
51.	Krus na Ligas	17,933	17,827	3,919
52.	Laging Handa	5,711	5,669	1,417
53.	Libis	5,902	5,902	1,372
54.	Lourdes	3,162	2,823	799
55.	Loyola Heights	14,252	13,775	3,330
56.	Maharlika	5,209	5.099	1,126
57.	Malaya	4,277	4,277	1,039
58.	Manresa	13,891	13,827	3,173
59.	Mangga	494	494	113
60.	Mariana	9,811	9,498	2,053
61.	Mariblo	3,835	3,835	863
62.	Marilag	8,762	8,762	2,003
63.	Masagana	4,117	4,117	913
64.	Masambong	11,935	11,918	2,589
65.	Matalahib (Santo Domingo)	12,940	12,929	3,087
66.	Matandang Balara	62,703	62,685	13,249
67.	Milagrosa	5,791	5,791	1,373
68.	Nagkaisang Nayon	38,598	38,598	8,655
69.	Nayong Kanluran	2,441	2,388	591

CITY / BARANGAY		TOTAL POPULATION	HOUSEHOLD POPULATION	NO. OF HOUSEHOLDS
70.	Novaliches Proper	12,078	12,038	2,736
71.	Obrero	8,108	7,965	1,836
72.	Old Capitol Site	1,956	1,956	422
73.	Paang Bundok	6,380	6,335	1,357
74.	Pag – Ibig sa Nayon	5,592	5,514	1,147
75.	Paligsahan	4,611	4,515	999
76.	Paltok	18,277	18,180	3,993
77.	Pansol	19,002	18,998	3,862
78.	Paraiso	3,659	3,659	788
79.	Pasong Putik Proper	20,804	20,635	4,278
80.	Pasong Tamo	64,656	64,656	13,809
81.	Phil – Am	3,197	3,152	595
82.	Pinyahan	28,258	28,240	6,751
83.	Pinagkaisahan	7,241	7,166	1,543
84.	Project 6	10,714	10,612	2,296
85.	Quirino 2 – A	4,856	4,856	1,284
86.	Quirino 2 – B	3,686	3,676	870
87.	Quirino 2 – C	2,897	2,897	719
88.	Quirino 3 – A	1,175	1,152	259
89.	Ramon Magsaysay	14,944	14,944	3,205
90.	Roxas	12,948	12,938	2,943
91.	Sacred Heart	6,812	6,812	2,009
92.	Saint Ignatius	1,628	1,628	296
93.	Saint Peter	5,080	4,280	935
94.	Salvacion	7,222	7,222	1,927
95.	San Agustin	20,850	20,728	4,792
96.	San Antonio	21,977	21,910	4,848
97.	San Bartolome	37,138	36,966	7,879
98.	San Isidro	6,319	6,319	1,376
99.	San Isidro Labrador	8,026	7,968	1,675
100.	San Jose	5,712	5,712	1,239
101.	San Martin de Porres	9,726	9,726	2,506
102.	San Roque	18,126	18,097	4,563
103.	San Vicente	6,132	6,132	1,417
104.	Santa Cruz	4,448	4,448	1,228
105.	Santa Lucia	18,724	18,724	3,979
106.	Santa Monica	27,354	27,192	5,791
107.	Santa Teresita	6,685	6,685	1,601
108.	Santo Cristo	9,310	8,952	2,069
109.	Santo Nino	9,453	9,453	2,299
110.	Santol	8,017	8,007	1,880
111.	Sauyo	30,018	30,018	6,671
112.	Sienna	5,414	5,354	1,412
113.	Sikatuna Village	5,835	5,813	1,195
114.	Silangan	5,223	5,223	1,301
115.	Socorro	19,260	19,216	4,815
116.	South Triangle	7,817	7,799	1,884

CITY / BARANGAY	TOTAL POPULATION	HOUSEHOLD POPULATION	NO. OF HOUSEHOLDS
117. Tagumpay	3,156	3,156	675
118. Talayan	4,683	4,683	1,126
119. Talipapa	26,747	26,680	5,849
120. Tandang Sora	46,500	46,493	9,829
121. Tatalon	52,074	52,009	12,267
122. Teachers Village East	2,973	2,973	686
123. Teachers Village West	3,801	3,765	805
124. U.P. Campus	23,226	23,145	5,186
125. U.P. Village	3,699	3,699	819
126. Ugong Norte	6,959	6,959	1,109
127. Unang Sigaw	6,505	6,505	1,505
128. Valencia	5,040	5,007	1,097
129. Vasra	6,256	6,256	1,473
130. Veterans Village	9,265	9,254	2,131
131. Villa Maria Clara	2,161	2,158	483
132. West Kamias	4,641	4,641	1,063
133. West Triangle	2,604	2,570	542
134. White Pains	3,791	3,778	725
135. Balong Bato	7,902	7,902	1,758
136. Capri	11,714	11,414	2,576
137. Sangandaan	21,377	21,289	4,894
138. Payatas	112,690	111,772	24,161
139. New Era	5,540	5,057	1,094
140. Holy Spirit	89,456	88,306	19,182
141. Greater Lagro	19,632	19,627	3,943
142. North Fairview	16,327	16,018	3,425

NCSO, 2000

Table 2. Population Projection by Barangay for Ten Years (2005-2014)

Name of Barangay	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Alicia	6,602	6,729	6,858	6,989	7,124	7,261	7,400	7,542	7,687	7,835
Amihan	4,550	4,637	4,726	4,817	4,909	5,003	5,099	5,197	5,297	5,399
Apolonio Samson	31,588	32,195	32,813	33,443	34,085	34,739	35,406	36,086	36,779	37,485
Aurora	5,686	5,795	5,906	6,020	6,135	6,253	6,373	6,495	6,620	6,747
Baesa	46,576	47,470	48,382	49,310	50,257	51,222	52,205	53,208	54,229	55,271
Bagbag	42,670	43,489	44,324	45,175	46,042	46,926	47,827	48,745	49,681	50,635
Bagumbuhay	7,600	7,746	7,895	8,047	8,201	8,358	8,519	8,683	8,849	9,019
Bagong Lipunan ng Crame	11,424	11,644	11,867	12,095	12,327	12,564	12,805	13,051	13,301	13,557
Bagong Pag-asa	43,158	43,986	44,831	45,692	46,569	47,463	48,374	49,303	50,250	51,215

Name of Barangay	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Bagong Silangan	35,739	36,425	37,124	37,837	38,564	39,304	40,059	40,828	41,612	42,411
Bagumbayan	8,355	8,515	8,679	8,845	9,015	9,188	9,364	9,544	9,728	9,914
Bahay Toro	59,517	60,659	61,824	63,011	64,221	65,454	66,711	67,992	69,297	70,628
Balingasa	21,209	21,616	22,031	22,454	22,885	23,324	23,772	24,229	24,694	25,168
Bayanihan	1,315	1,341	1,366	1,393	1,419	1,446	1,474	1,502	1,531	1,561
Blue Ridge A	1,841	1,876	1,912	1,949	1,987	2,025	2,064	2,104	2,144	2,185
Blue Ridge B	1,479	1,508	1,537	1,566	1,596	1,627	1,658	1,690	1,722	1,755
Botocan	8,140	8,297	8,456	8,618	8,784	8,953	9,125	9,300	9,478	9,660
Bungad	11,196	11,410	11,630	11,853	12,080	12,312	12,548	12,789	13,035	13,285
Camp Aguinaldo	4,820	4,913	5,007	5,103	5,201	5,301	5,403	5,506	5,612	5,720
Central	13,195	13,448	13,706	13,970	14,238	14,511	14,790	15,074	15,363	15,658
Claro	4,344	4,427	4,512	4,599	4,687	4,777	4,869	4,962	5,057	5,155
Commonwealth	132,597	135,143	137,737	140,382	143,077	145,824	148,624	151,477	154,386	157,350
Batasan Hills	120,669	122,986	125,347	127,754	130,206	132,706	135,254	137,851	140,498	143,195
Kristong Hari	3,895	3,970	4,046	4,124	4,203	4,284	4,366	4,450	4,535	4,622
Culiat	54,591	55,639	56,707	57,796	58,906	60,037	61,190	62,365	63,562	64,782
Damar	1,816	1,851	1,886	1,922	1,959	1,997	2,035	2,074	2,114	2,154
Damayan	9,632	9,817	10,005	10,197	10,393	10,593	10,796	11,003	11,214	11,430
Damayang Lagi	18,432	18,786	19,147	19,514	19,889	20,271	20,660	21,057	21,461	21,873
Del Monte	14,265	14,539	14,818	15,102	15,392	15,688	15,989	16,296	16,609	16,927
Dioquino Zobel	2,063	2,103	2,143	2,184	2,226	2,269	2,312	2,357	2,402	2,448
Dona Imelda	17,282	17,613	17,952	18,296	18,648	19,006	19,371	19,743	20,122	20,508
Dona Josefa	2,610	2,660	2,711	2,763	2,816	2,870	2,925	2,981	3,039	3,097
Don Manuel	3,606	3,675	3,746	3,818	3,891	3,966	4,042	4,119	4,199	4,279
Duyan – Duyan	3,008	3,066	3,124	3,184	3,246	3,308	3,372	3,437	3,503	3,570
E. Rodriguez	18,667	19,026	19,391	19,763	20,143	20,530	20,924	21,326	21,735	22,152
East Kamias	7,064	7,199	7,338	7,478	7,622	7,768	7,917	8,070	8,224	8,382
Escopa 1	2,255	2,298	2,342	2,387	2,433	2,480	2,527	2,576	2,625	2,676
Escopa 2	2,266	2,309	2,353	2,399	2,445	2,492	2,540	2,589	2,638	2,689
Escopa 3	8,324	8,484	8,647	8,813	8,982	9,154	9,330	9,509	9,692	9,878

Name of Barangay	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Escopa 4	1,881	1,917	1,953	1,991	2,029	2,068	2,108	2,148	2,189	2,231
Fairview	33,358	33,998	34,651	35,316	35,994	36,685	37,389	38,107	38,839	39,585
N.S. Amoranto (Gintong Silahis)	7,353	7,494	7,638	7,785	7,934	8,086	8,242	8,400	8,561	8,725
Gulod	51,365	52,352	53,357	54,381	55,425	56,489	57,574	58,679	59,806	60,954
Horseshoe	3,098	3,157	3,218	3,280	3,343	3,407	3,473	3,539	3,607	3,676
Immaculate Concepcion	10,087	10,281	10,478	10,679	10,884	11,093	11,306	11,523	11,744	11,970
Kaligayahan	32,540	33,164	33,801	34,450	35,112	35,786	36,473	37,174	37,887	38,615
Kalusugan	2,506	2,554	2,604	2,654	2,704	2,756	2,809	2,863	2,918	2,974
Kamuning	15,964	16,271	16,583	16,901	17,226	17,557	17,894	18,237	18,588	18,944
Katipunan	2,154	2,196	2,238	2,281	2,325	2,370	2,415	2,462	2,509	2,557
Kaunlaran	9,042	9,216	9,393	9,573	9,757	9,944	10,135	10,330	10,528	10,730
Krus na Ligas	19,722	20,101	20,487	20,880	21,281	21,690	22,106	22,530	22,963	23,404
Laging Handa	6,281	6,401	6,524	6,649	6,777	6,907	7,040	7,175	7,313	7,453
Libis	6,491	6,615	6,742	6,872	7,004	7,138	7,276	7,415	7,558	7,703
Lourdes	3,477	3,544	3,612	3,682	3,752	3,824	3,897	3,972	4,049	4,126
Loyola Heights	15,674	15,975	16,281	16,594	16,913	17,238	17,569	17,906	18,250	18,600
Maharlika	5,729	5,839	5,951	6,065	6,181	6,300	6,421	6,544	6,670	6,798
Malaya	4,704	4,794	4,886	4,980	5,075	5,172	5,272	5,373	5,476	5,581
Manresa	15,277	15,570	15,869	16,174	16,484	16,800	17,123	17,452	17,787	18,128
Mangga	543	554	564	575	586	597	609	620	632	644
Mariana	10,790	10,997	11,208	11,423	11,643	11,867	12,094	12,327	12,563	12,804
Mariblo	4,218	4,299	4,381	4,465	4,551	4,638	4,727	4,818	4,911	5,005
Marilag	9,636	9,821	10,010	10,202	10,398	10,598	10,801	11,008	11,220	11,435
Masagana	4,528	4,615	4,703	4,794	4,886	4,980	5,075	5,173	5,272	5,373
Masambong	13,126	13,378	13,634	13,896	14,163	14,435	14,712	14,995	15,282	15,576
Matalahib (Santo Domingo)	14,231	14,504	14,783	15,066	15,356	15,651	15,951	16,258	16,570	16,888
Matandang Balara	68,958	70,282	71,632	73,007	74,409	75,838	77,294	78,778	80,290	81,832
Milagrosa	6,369	6,491	6,616	6,743	6,872	7,004	7,138	7,275	7,415	7,558
Nagkaisang Nayon	42,448	43,263	44,094	44,941	45,804	46,683	47,580	48,493	49,424	50,373
Nayong Kanluran	2,685	2,736	2,789	2,842	2,897	2,953	3,009	3,067	3,126	3,186

Name of Barangay	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Novaliches Proper	13,283	13,538	13,798	14,063	14,333	14,608	14,889	15,175	15,466	15,763
Obrero	8,917	9,088	9,263	9,440	9,622	9,807	9,995	10,187	10,383	10,582
Old Capitol Site	2,151	2,192	2,235	2,277	2,321	2,366	2,411	2,457	2,504	2,553
Paang Bundok	7,016	7,151	7,288	7,428	7,571	7,716	7,865	8,016	8,169	8,326
Pag – Ibig sa Nayon	6,150	6,268	6,388	6,511	6,636	6,763	6,893	7,026	7,161	7,298
Paligsahan	5,071	5,168	5,268	5,369	5,472	5,577	5,684	5,793	5,905	6,018
Paltok	20,100	20,486	20,880	21,280	21,689	22,105	22,530	22,962	23,403	23,853
Pansol	20,898	21,299	21,708	22,125	22,549	22,982	23,423	23,873	24,331	24,798
Paraiso	4,024	4,101	4,180	4,260	4,342	4,425	4,510	4,597	4,685	4,775
Pasong Putik Proper	22,879	23,319	23,766	24,223	24,688	25,162	25,645	26,138	26,639	27,151
Pasong Tamo	71,106	72,471	73,863	75,281	76,726	78,199	79,701	81,231	82,790	84,380
Phil – Am	3,516	3,583	3,652	3,722	3,794	3,867	3,941	4,017	4,094	4,172
Pinyahan	31,077	31,674	32,282	32,902	33,533	34,177	34,833	35,502	36,183	36,878
Pinagkai-sahan	7,963	8,116	8,272	8,431	8,593	8,758	8,926	9,098	9,272	9,450
Project 6	11,783	12,009	12,240	12,475	12,714	12,958	13,207	13,460	13,719	13,982
Quirino 2 – A	5,340	5,443	5,547	5,654	5,763	5,874	5,986	6,101	6,219	6,338
Quirino 2 – B	4,054	4,132	4,211	4,292	4,374	4,458	4,544	4,631	4,720	4,810
Quirino 2 – C	3,186	3,247	3,310	3,373	3,438	3,504	3,571	3,640	3,710	3,781
Quirino 3 – A	1,292	1,317	1,342	1,368	1,394	1,421	1,448	1,476	1,504	1,533
Ramon Magsaysay	16,435	16,750	17,072	17,400	17,734	18,074	18,422	18,775	19,136	19,503
Roxas	14,240	14,513	14,792	15,076	15,365	15,660	15,961	16,267	16,579	16,898
Sacred Heart	7,492	7,635	7,782	7,931	8,084	8,239	8,397	8,559	8,723	8,890
Saint Ignatius	1,790	1,825	1,860	1,896	1,932	1,969	2,007	2,045	2,085	2,125
Saint Peter	5,587	5,694	5,803	5,915	6,028	6,144	6,262	6,382	6,504	6,629
Salvacion	7,942	8,095	8,250	8,409	8,570	8,735	8,902	9,073	9,247	9,425
San Agustin	22,930	23,370	23,819	24,276	24,742	25,217	25,701	26,195	26,698	27,210
San Antonio	24,169	24,633	25,106	25,588	26,080	26,581	27,091	27,611	28,141	28,682
San Bartolome	40,843	41,627	42,426	43,241	44,071	44,917	45,780	46,659	47,554	48,467
San Isidro	6,949	7,083	7,219	7,357	7,499	7,643	7,790	7,939	8,092	8,247
San Isidro Labrador	8,827	8,996	9,169	9,345	9,524	9,707	9,893	10,083	10,277	10,474

Name of Barangay	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
San Jose	6,282	6,402	6,525	6,651	6,778	6,908	7,041	7,176	7,314	7,454
San Martin de Porres	10,696	10,902	11,111	11,324	11,542	11,764	11,989	12,220	12,454	12,693
San Roque	19,934	20,317	20,707	21,105	21,510	21,923	22,344	22,773	23,210	23,656
San Vicente	6,744	6,873	7,005	7,140	7,277	7,417	7,559	7,704	7,852	8,003
Santa Cruz	4,892	4,986	5,081	5,179	5,278	5,379	5,483	5,588	5,695	5,805
Santa Lucia	20,592	20,987	21,390	21,801	22,219	22,646	23,080	23,524	23,975	24,436
Santa Monica	30,083	30,660	31,249	31,849	32,461	33,084	33,719	34,367	35,027	35,699
Santa Teresita	7,352	7,493	7,637	7,784	7,933	8,085	8,241	8,399	8,560	8,724
Santo Cristo	10,239	10,435	10,636	10,840	11,048	11,260	11,476	11,697	11,921	12,150
Santo Nino	10,396	10,596	10,799	11,006	11,218	11,433	11,653	11,877	12,105	12,337
Santol	8,817	8,986	9,159	9,334	9,514	9,697	9,883	10,073	10,266	10,463
Sauyo	33,013	33,646	34,292	34,951	35,622	36,306	37,003	37,713	38,438	39,176
Sienna	5,954	6,068	6,185	6,304	6,425	6,548	6,674	6,802	6,933	7,066
Sikatuna Village	6,417	6,540	6,666	6,794	6,924	7,057	7,192	7,331	7,471	7,615
Silangan	5,744	5,854	5,967	6,081	6,198	6,317	6,438	6,562	6,688	6,816
Socorro	21,181	21,588	22,003	22,425	22,856	23,295	23,742	24,198	24,663	25,136
South Triangle	8,597	8,762	8,930	9,102	9,276	9,454	9,636	9,821	10,009	10,201
Tagumpay	3,471	3,537	3,605	3,675	3,745	3,817	3,890	3,965	4,041	4,119
Talayan	5,150	5,249	5,350	5,453	5,557	5,664	5,772	5,883	5,996	6,111
Talipapa	29,415	29,980	30,556	31,142	31,740	32,349	32,971	33,604	34,249	34,906
Tandang Sora	51,139	52,121	53,121	54,141	55,181	56,240	57,320	58,421	59,543	60,686
Tatalon	57,269	58,368	59,489	60,631	61,795	62,981	64,191	65,423	66,679	67,960
Teachers Village East	3,270	3,332	3,396	3,462	3,528	3,596	3,665	3,735	3,807	3,880
Teachers Village West	4,180	4,260	4,342	4,426	4,511	4,598	4,686	4,776	4,868	4,961
U.P. Campus	25,543	26,033	26,533	27,043	27,562	28,091	28,631	29,180	29,741	30,312
U.P. Village	4,068	4,146	4,226	4,307	4,390	4,474	4,560	4,648	4,737	4,828
Ugong Norte	7,653	7,800	7,950	8,103	8,258	8,417	8,578	8,743	8,911	9,082
Unang Sigaw	7,154	7,291	7,431	7,574	7,719	7,867	8,018	8,172	8,329	8,489
Valencia	5,543	5,649	5,758	5,868	5,981	6,096	6,213	6,332	6,454	6,578
Vasra	6,880	7,012	7,147	7,284	7,424	7,567	7,712	7,860	8,011	8,165

Name of Barangay	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Veterans Village	10,189	10,385	10,584	10,787	10,995	11,206	11,421	11,641	11,864	12,092
Villa Maria Clara	2,377	2,422	2,469	2,516	2,564	2,613	2,663	2,715	2,767	2,820
West Kamias	5,104	5,202	5,302	5,404	5,507	5,613	5,720	5,830	5,942	6,056
West Triangle	2,864	2,919	2,975	3,032	3,090	3,149	3,210	3,271	3,334	3,398
White Pains	4,169	4,249	4,331	4,414	4,499	4,585	4,673	4,763	4,855	4,948
Balong Bato	8,690	8,857	9,027	9,201	9,377	9,557	9,741	9,928	10,118	10,312
Capri	12,883	13,130	13,382	13,639	13,901	14,168	14,440	14,717	15,000	15,288
Sangandaan	23,510	23,961	24,421	24,890	25,368	25,855	26,351	26,857	27,373	27,899
Payatas	123,932	126,311	128,736	131,208	133,727	136,295	138,911	141,579	144,297	147,067
New Era	6,093	6,210	6,329	6,450	6,574	6,700	6,829	6,960	7,094	7,230
Holy Spirit	98,380	100,269	102,194	104,156	106,156	108,194	110,272	112,389	114,547	116,746
Greater Lagro	21,590	22,005	22,427	22,858	23,297	23,744	24,200	24,665	25,138	25,621
North Fairview	17,956	18,300	18,652	19,010	19,375	19,747	20,126	20,513	20,906	21,308

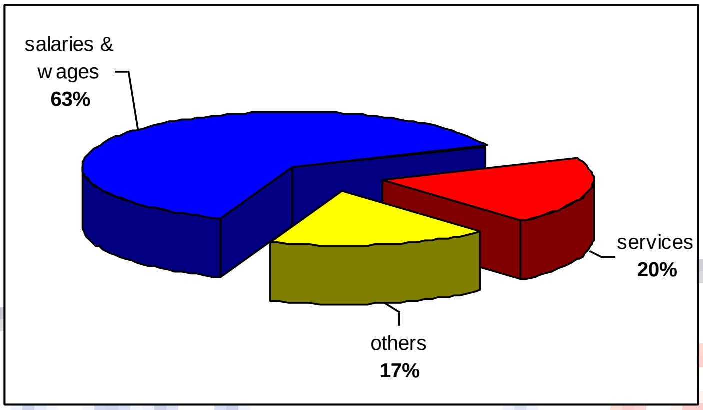
2.4 ECONOMIC PROFILE / LAND USE

2.4.1 Economy

The average family income in Quezon City is P32,757 per month, which is above the P8,857 poverty level (NSO, 2000). The main source of family income comes from wages and salaries (63%) followed by entrepreneurial services (20%) and others such as pensions and assistance from abroad (17%). The average family expenditure, on the other hand, is about P29,577 per month.

Presently, there is a predominance of small to medium scale type of business operations engaged mostly in the distribution of finished products rather than in the production of goods. The number of large business establishments in the City is minimal although they contribute a big share in business revenue.

Figure 1. Main Sources of income



Source: National Statistics Office (2000)

Records from the Quezon City Business Permits and Licensing Office (BPLO) revealed that in the year 2004, the total number of business establishments in the City is 157,581. With the big portion of the City's land area delineated for commercial and industrial development and the availability of manpower resources, there remains a great potential to substantially increase the number of businesses in the City. Table 3 shows the list of industries operating in the City.

The City also charges garbage fees from all business establishments only upon application and renewal of their business permits. The garbage fee being charged ranges from a minimum of P80 to a maximum of P12,000 per annum depending on the classification and size of business establishment. With regards to the collection and disposal of waste, most big establishments especially hotels, shopping centers, fast food centers and restaurants are contracting the services of private haulers/recyclers to collect their waste. In some cases, the private recyclers are the ones paying these establishments specially those that generate large volume of recyclables.

The City's mode of transportation is purely land-based. There are major transport systems and routes that are available for *commuters and motorists in addition to the existing roads/streets and main thoroughfares such as the MRT Line 3 (EDSA) and LRT Line 2 (Aurora), Circumferential Road 5 (C-5), and Circumferential Road 6 (C-6), Quezon Avenue/EDSA Interchange. Roosevelt/EDSA Interchange will soon be open for the public. All these major transport projects will ease the traffic congestions in Quezon City once fully operational.*

Table 3 Type and Number of Establishments

Type of Establishment	Total Number of Establishment
DISTRICT 1	
1. Charitable Institution	6
2. Eating Place	1,960
3. Financial Establishment	714
4. Importer	1,785
5. Learning Institution	125
6. Manufacturer	1,186
7. Other Business with Fix Rate	8,251
8. Shopping Center	16
9. Wholesaler	6,793
DISTRICT 2	
1. Amusement Place	415
2. Contractor	12,194
3. Eating Place	1,685
4. Exporter	294
5. Financial Establishment	777
6. Importer	632
7. Learning Institution	240
8. Manufacturer	1,330
9. No Description	4
10. Other Business with Fix Rate	8,744
11. Retailer	17,846
12. Shopping Center	29
13. Wholesaler	5,589
DISTRICT 3	
1. Amusement Place	432
2. Charitable Institution	9
3. Contractor	10,383
4. Eating Place	2,338

Type of Establishment	Total Number of Establishment
5. Exporter	224
6. Financial Establishment	771
7. Importer	580
8. Learning Institution	127
9. Manufacturer	459
10. Other Business with Fix Rate	6,817
11. Retailer	12,142
12. Shopping Center	19
13. Wholesaler	4,499
DISTRICT 4	
1. Amusement Place	501
2. Contractor	13,937
3. Eating Place	2,711
4. Exporter	366
5. Financial Establishment	828
6. Importer	1,274
7. Learning Institution	138
8. Manufacturer	707
9. Other Business	12
10. Other Business with Fix Rate	8,424
11. Retailer	13,000
12. Shopping Center	13
13. Wholesaler	6,255
TOTAL OF DISTRICTS 1-4	**157,581**

Source: QC Business Permits and Licensing Office, 2004

2.4.2 Land Use

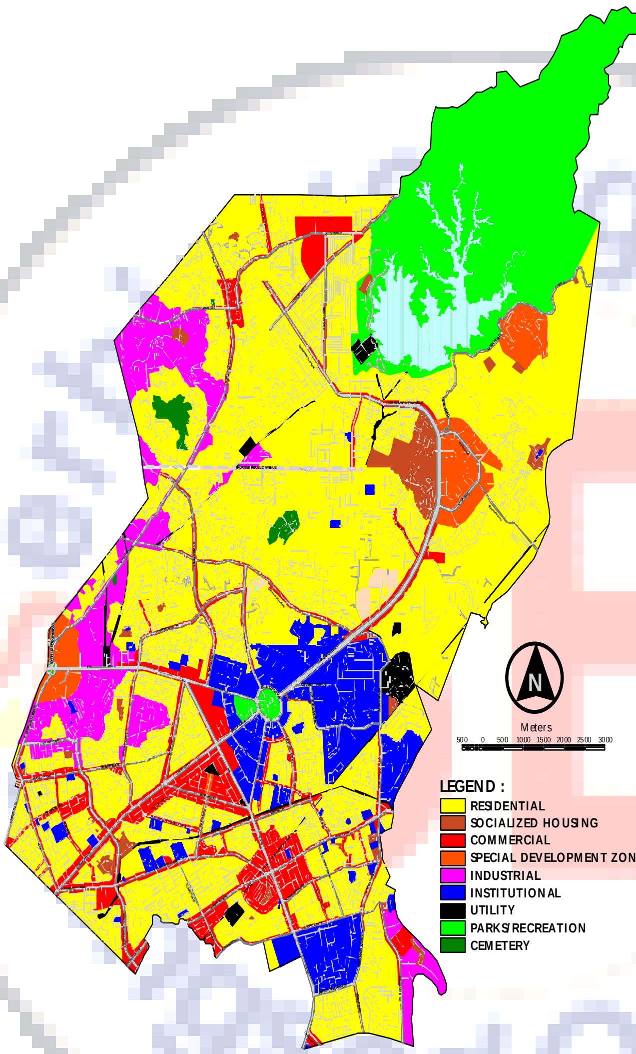
Residential use still dominates the city's urban structure (97%). Commercial establishments occupy a mere two percent (2%) of land space, clustered along main roads and with the heaviest presence at major intersections.

Industrial development remains confined to traditional zones in the north, near the older industrial areas of Kalookan and Valenzuela.

The location indicates that the City's industrial activities are a result of expansion until the Regional Dispersal Policy, restricting further industrial sprawl within Metro Manila, was enacted by the national government.

Figures 2 and 3 shows Quezon City's Comprehensive Land Use Map and the Comparative Zone Distribution as approved under City Ordinance No. SP-1369, S-2003 and as amended by City Ordinance No. SP-1379, S-2004. Presently, the City is predominantly residential with a significantly large area devoted to institutional uses.

Figure 2. Comprehensive Land Use Map



	Area (has.)	% to total Area
Resd'l	7,437.60	46.16
Socialized Housing	266.29	1.65
Commercial	1,296.96	8.05
SDZ	437.16	2.71
Ind'l	957.49	5.94
Inst'l	1,135.32	7.05
Utility	212.79	1.32
Parks / Recreation	2,595,27	16.11
Cemetery	74.57	0.46
Roads & Waterways	1,698.64	10.54

	ZONING 1981 (has.)	ZONING As amended (has.)	DIFFERENCE (has.)	% (increase / decrease)
RESD'L 1	2,365.13	1,121.23	-1,243.90	-52.59
RESD'L 2	3,247.75	4,451.11	1,203.36	37.05
RESD'L 3	679.01	1,865.26	1,186.25	174.70
SOCIALIZED HOUSING	0.00	266.29	266.29	100.00
COMM'L 1	0.00	249.83	249.83	100.00
COMM'L 2	587.80	764.47	176.67	30.06
COMM'L 3	249.45	282.66	33.21	13.31
INDUS'L 1	187.17	128.70	-58.47	-31.24
INDUS'L 2	644.58	828.80	184.22	28.58
INST'L	896.86	1,135.32	238.46	26.59
MILITARY	193.85	0.00	-193.85	-100.00
APD	2,624.33	0.00	-2,624.33	-100.00
UTILITY	87.24	212.79	125.55	143.91
PARKS / RECREATIONAL	2,783.14	2,595.27	-187.87	-6.75
SPL DEVT ZONE	37.83	437.16	399.33	1055.59
CEMETERY	0.00	74.57	74.57	100.00
ROADS / WATERWAYS	1,527.99	1,698.74	170.79	11.20
TOTAL	16,112.12	16,112.12		

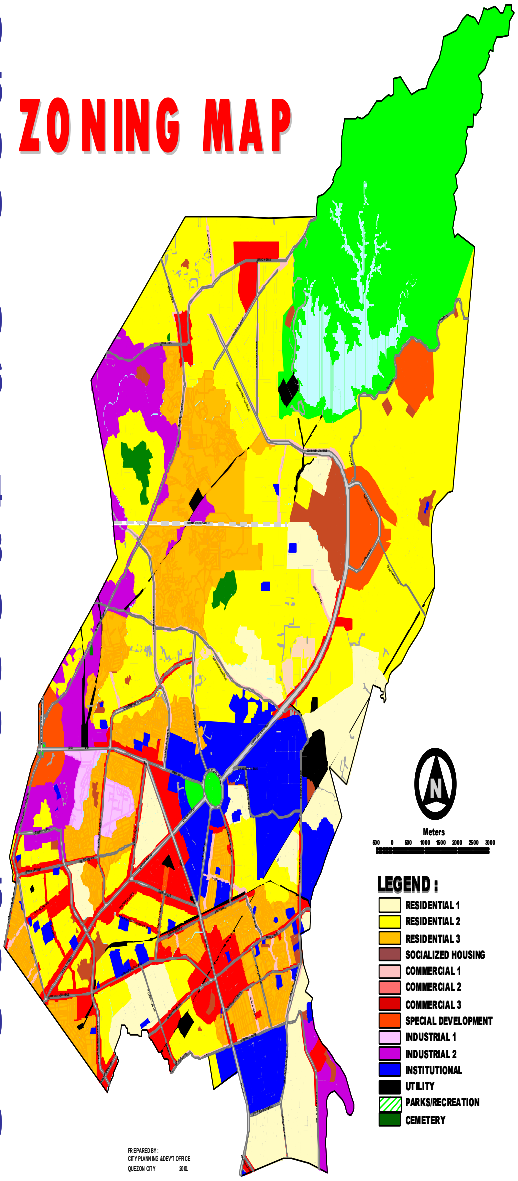


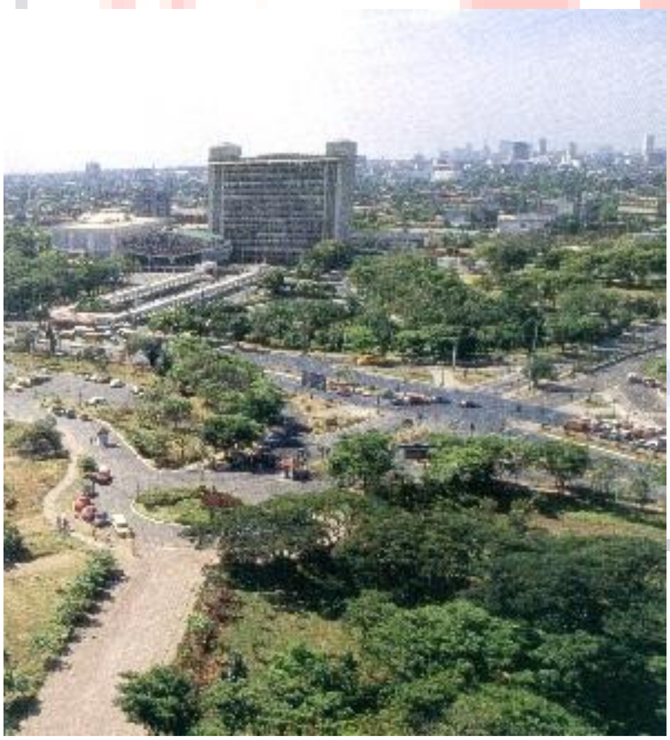
Figure 3. Comparative Zone Distribution

Table 4. Land Use

CLASSIFICATION	AREA (hectares)	PERCENTAGE (%)
Residential	8,502.82	56.29
Commercial	255.87	1.70
Industrial	870.80	5.76
Institutional	725.58	4.80
Military	226.50	1.50
Parks/Recreational Sites	161.05	1.07
Open Lands	1,759.88	11.65
Waterways	138.00	0.91
Novalichers Reservoir	2,465	16.32

2.5 PHYSICAL CHARACTERISTICS

2.5.1 Geographical Features



Quezon City is 10 kms. north of Manila. It is five (5) times bigger than Manila in area. It is the second to the country's biggest city - Davao City. Rolling hills spread over a large portion of Quezon City. Its lowest altitude is 25 feet above sea level, while its highest is 55 feet.

2.5.2 Climate

Weather condition is generally fair, with the highest amount of rainfall occurring during the months of May to November of every year. Average temperature is low at 25˚C, usually in January, and high at 29˚C in May.

III. CURRENT SOLID WASTE MANAGEMENT CONDITIONS

3.1 Institutional Arrangements

Solid waste management system in Quezon City can be traced back to the issuance of several laws/orders pertaining to solid waste management.

Presidential Decree No. 824 issued on November 7, 1975 created the Metropolitan Manila Area, a geographical unit composed of 4 cities and 13 municipalities (now 16 cities and 1 municipality). Quezon City is one of the metropolitan cities that formed part of the said geographical unit.

With its creation, Executive Order No. 5 was passed, paving the way for the creation of the Refuse and Environmental Sanitation Center (RESC), which was later changed to Environmental Sanitation Center (ESC).

On January 1, 1990, through Executive Order No. 392, the Metropolitan Manila Commission (MMC) was converted into a management-council type organization and was renamed Metro Manila Authority (MMA), with the mayors of the cities/municipalities comprising the Council. Like MMC, it was vested jurisdiction over the delivery of basic services requiring coordination including sanitation and waste management.

The signing of Republic Act No. 7160, otherwise known as the Local Government Code of 1991 paved the way to the enactment of MMA Resolution No.9087 in August 1992. This Resolution turned over the responsibility of garbage collection to the LGUs while disposal operations remained the responsibility of MMA which was later renamed Metro Manila Development Authority (MMDA). This was later reaffirmed with the execution of a Memorandum of Agreement (MOA) between MMDA and the 17 LGUs through Metro Manila Council Resolution No. 01, Series of 1992. This agreement allowed LGUs to have operational control and supervision over solid waste management functions within their respective jurisdiction.

As an off-shoot of the devolution of environmental management functions to the LGU's, Task Force Clean & Green under the Office of the Mayor of Quezon City was created by virtue of Memorandum Order No. 2, Series of 1992. This Task Force took over the responsibility of solid waste management, among others, for the City. It served for nine (9) years until City Ordinance No. 982, Series of 2000 was passed, creating the Quezon City Environmental Protection and Waste Management Department (QC-EPWMD).

QC-EPWMD is tasked with the following:

- To develop and directly administer a comprehensive environmental protection program which will specifically cover solid waste management and pollution control;

- To maintain and operate a garbage collection and disposal system that conforms to the requirements of environmental laws;

- To enforce all laws, regulations and policies pertaining to environmental management and pollution control;

- To institute a standard monitoring system in the delivery of garbage collection services in the City;

- To formulate civic consciousness programs geared towards environmental sanitation, e.g. cleanliness, proper waste segregation, disposal and recycling in the barangays, to be implemented in coordination with other non-governmental organizations;

- To establish linkages and coordinate with offices of the City Government and other national and local government agencies for the promotion of environmental management programs and projects in the City;

- To maintain and operate a comprehensive pollution control program to include anti-smoke belching and industrial pollution control;

- To undertake continuing studies and researches on environmental management with the end in view of introducing modern concepts and technologies that can be adopted by the City in the light of existing conditions, regulations and sustainability.

3.2 Inventory of Equipment and Staff

The garbage collection and disposal services have been awarded to winning waste haulers/contractors in a bidding held by the City. Equipment for the operation and maintenance and personnel are the responsibility of the Contractor. Service fleet for the collection of garbage varies in types and sizes i.e. 10-wheeler, 6-wheeler, Mini Dumptrucks, Compactors, Mini Compactors, etc. The use of Payloaders is also required from the Contractors especially when manual collection is not possible.

For its part, the Department uses the following equipment in its daily operation:

Table 5. Equipment at the Operation Office

Article	Equipment	Number
Office Equipment	Risograph	1
	Puncher	4
	Typewriter	2
	Copying Machine	1
IT Equipment and Software	Computer	28
	Printer	9
	UPS	16
Communication Equipment	VCD Player	1
	Television	1
	Fax Machine	1
	Two-Way Radio	11
	Two-Way Radio Base	1
	Sound System	2
	Sony Handy Camera Recorder	1
Other Properties	Aircondition	8
	Digital Camera	5
	Electric Fan	5
	Projector Screen	1
	Video Projector	1
Other Machinery and Equipment	Generator Set	1
Service Vehicle	SUV	5
	Motorcycle	14

The Department has a total of 408 plantilla positions. However, it has only 183 existing personnel, mostly under contract of services. The distribution of personnel by section/action unit is as follows:

Table 6. Distribution of ESWMD Personnel

Office / Division	No. of Personnel
Office of the Department Head	1
Administrative Division	17
Plans and Programs Division	19
Special Project Evaluation Section	1

Office / Division	No. of Personnel
Solid Waste Management Division's Doc. & Consolidation Section	9
Special Cleaning Section	6
Environmental Enforcement & Inspection Section	38
District I Dispatching	8
District II Dispatching	13
District III Dispatching	7
District IV Dispatching	8
Pollution Control Division	24
Detailed to other Offices	16
Detailed from other Offices	16
Total	**183**

3.3 Source Reduction

3.3.1 Source Reduction Programs

Sinop Basura sa Barangay. A Community-Based SWM Program aimed at reducing the volume of solid waste from source by segregation of waste and the implementation of separate collection or the "No Segregation, No Collection" scheme.

Junkshop Standardization Program. Aimed at incorporating the operation of junkshops to the City's SWM Program. It is important to note the role these junkshops play in the over-all waste diversion of the City. EPWMD is also currently organizing the operations of these junkshops to provide them with technical training and directions.

Ecological Solid Waste Management Program at Quezon City Hall. In an effort to promote the City's Solid Waste Management Program and consequently, demonstrate moral ascendancy to its constituents, regular recyclables collection event is being conducted. All Departments, Offices and Units within the QC Hall

Complex are directed to observe proper waste segregation and resource recovery in their respective working areas.

3.3.2 Complementary Programs on SWM

Door-to-Door Collection System. The door-to-door collection system is specifically implemented in areas that are not accessible to big collection trucks due to its narrow streets, low electrical wirings, no right of way, to name a few. The system makes use of push carts to collect wastes and then transferred to the dumptrucks stationed along accessible areas. The wastes from the pushcarts will not in any way touch the ground.

Of the identified 268 inaccessible areas located at 54 barangays, 162 inaccessible areas in 33 barangays have already this type of system in operation.

Deployment of Street Sweepers. The presence of waste along the roads despite the regular collection of garbage is one of the problems encountered by the City. To address this, Hauling Contractors were required to deploy fifty (50) street sweepers per district/sub-district at no expense on the part of the City Government. These street sweepers are stationed in the 41 main roads of the City and are tasked to maintain the cleanliness of the streets by daily sweeping, grass cutting, gutter painting, among others.

Riverways Management. Recognizing the need to also address the deteriorating conditions of the City's waterways as a result of indiscriminate throwing of solid wastes, a Waterways Clean-Up Program was implemented that is spearheaded by the Riverways Sanitation Services (RSS). This group performs regular cleaning and clearing operations in all the waterways surrounding the City. An annual implementation of the Sagip Batis sa QC

Program is also being implemented to complement the daily operations of the RSS.

Legislation and Strict Enforcement of Environmental Laws and Ordinances. To ensure that the SWM program is widely implemented and followed, several laws and ordinances were passed and enforced by the City. A total of 32 Environment Police have been deputized and employed to take on the responsibility of apprehending violators of these ordinances.

3.4 Compliance to R.A. 9003

3.4.1 Constitution of the Barangay Solid Waste Management Committee (BSWMC)

To date, only 64.08% of the City's barangays have constituted their BSWMCs, which essentially would be the driving force in implementing Solid Waste Management Programs at the barangay level. Below is the total no. of barangays with SWM Committees per district.

Table 7. Number of Barangays with SWM Committee

District	No. of Barangays	Barangays with SWM Committees	Percentage
District I	37	21	56.76
District II	30	19	63.33
District III	37	18	48.65
District IV	38	33	86.84
Total	**142**	**91**	**64.08%**

3.4.2 Formulation of the Barangay Solid Waste Management Plan

Only 21.13% of the City's barangays has laid down concrete plans and targets in their Solid Waste Management Plans.

Table 8. Number of Barangays with SWM Plans

District	No. of Barangays	Barangays with SWM Plans	Percentage
District I	37	4	10.81
District II	30	8	26.67
District III	37	4	10.81
District IV	38	14	36.84
Total	**142**	**30**	**21.13%**

3.4.3 Establishment of Barangay Materials Recovery Facility (MRF)

Due to space inadequacy and lack of financial resources, only 36 Barangays have their own MRFs for their composting and/or recycling activities.

Table 9. Number of Barangays with MRF

District	No. of Barangays	No. of MRFs
District I	37	9
District II	30	7
District III	37	10
District IV	38	11
Total	**142**	**36**

3.5 Collection

3.5.1 Existing System

The City is implementing a Macro and Micro Cell-Based Collection System, wherein the waste generation of an area or a cell is equivalent to one truckload of garbage or 16 cubic meters of wastes. This system of collection was established for the following purposes:

- *To know the required number of vehicles needed to collect the daily waste generation of Quezon City.*
- *For proper coding of the service area.*
- *For proper scheduling of waste collection.*

The Cell-Based Collection System is also being used as basis for the Package Clean-Up Contract with the waste haulers/contractors. Under this type of Contract, the contractor is given full responsibility to manage, administer and directly carry out collection, cleaning and disposal of solid waste from various sources.

3.5.2 Service Area / Routes / Frequency of Collection

In terms of collection schedule, Quezon City has three (3) service schedules:

- *Main Thoroughfares - collection of garbage is done daily from 4:00 AM to 7:00 AM, with mopping-up operations not later than 9:00 A.M. and 2:00 P.M. Mopping or follow-up collections are undertaken to collect late and untimely disposals. The main thoroughfare areas are of mixed sectors, composed mostly of commercial establishments, some industries and residential houses.*

- *Stationary collection – route for public markets and hospitals (domestic wastes only). Collection is done on a daily basis. For government-owned institutions, collection of waste depends on waste volume. Collection is done on a daily, twice or thrice weekly basis.*

- *Barangay (residential) collection - scheduled twice-a-week: Mondays & Thursdays, Tuesdays and Fridays, and Wednesdays & Saturdays. The Barangay areas are composed mostly of residential houses mixed with some other sectors like commercial and industrial, etc.*

Segregated collection of waste is not yet fully implemented in the City although it is being done in some barangays especially those practicing good solid waste management in coordination with the City. Some residential areas are also practicing waste segregation at source in view of the proliferation of junkshops buying recyclable materials.

3.5.3 Barangays with Own Collection Trucks

Some of the barangays deploy their own garbage trucks in collecting household wastes from selected pilot areas within their jurisdiction. Collected wastes are being disposed at the Payatas Controlled Disposal Facility.

Table 10. Barangays with Garbage Trucks

Barangay	Cell Required	Cell Covered	Cell Number
Batasan Hills	30	11	R-78, 82, 83, 84, 94, 96, 97, 103, 108, 109, 110
Bagong Silangan	11	2	R-71 and R-74
Tatalon	13	1	R-81
Holy Spirit	*Have been using their own collection trucks since the administration of Mayor Ishmael Mathay.*		

3.6 Transfer

Quezon City has no existing facility for the transfer of solid waste prior to final disposal given the proximity of the City's disposal area, which is the Payatas Controlled Disposal Facility.

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3.7 Processing Facilities

Materials Recovery Facilities (MRFs) have been established in several barangays like Barangays Holy Spirit, Phil-am, Bagumbuhay, Vasra, etc. for the processing of collected wastes. A central trading area has also been established in the Payatas Controlled Disposal Facility where the scavengers bring the recyclable materials they have collected.

3.8 Final Disposal

The City's solid wastes are disposed at the Payatas Controlled Disposal Facility (Payatas CDF) located at Barangay Payatas, District II. From an open dumpsite, the disposal area was converted into a CDF in the year 2004. This covered the engineering remediation that will ensure the safety and stability of the dumpsite and enhance the environmental condition of the locality. The Project also addressed the social and financial problems of the people living and working within the disposal facility by giving them alternative livelihood, shelter, scholarships and other capacity building programs that will support their well-being.

The following were the major activities incorporated in the conversion project:

1. Slope Re-profiling – The slope of the dumpsite, which was about 60-70 degrees, was reduced to about 23-25 degrees for slope stability. Dumping areas were covered with soil (0.60 meter thick) and then compacted.

2. Slope Benching or Berm – constructed every 10 meters of slope length to minimize slope erosion and serve as maintenance road.

3. Leachate Collection and Re-circulation – leachate is collected in a leachate pumping station separate from the storm water drain. The leachate is re-circulated through pumps onto the soil capped mounds to water the vetiver grass and other flowering plants. Leachate re-circulation treats the leachate through aeration process and helps enhance decomposition.

4. Installation of Storm Water Drain – acts as catch basin for surface water run-off from the dumpsites and adjacent areas. Sandbags were piled to prevent the wash-out of the toe of the dumpsite.

5. Planting of Vetiver Grass – acts as slope erosion control and proven to be effective in controlling heavy metals in soil due to its good root system thus minimizing the pollution discharge in the waterways.

6. Payatas Gas to Power Generation – the One-Hundred Kilowatt engine generator is now operational. It is the present source of electricity of the biowaste processing facility, "plantsahan ng Bayan" and lighting during night operations.

7. Tire Retrieval Project – used car tires are being collected, cleaned and transported to HOLCIM Philippines (formerly Union Cement Corporation), which uses the tires as alternative fuel in the Cement Kiln Co-processing system.

8. Biodegradable Waste Processing Facility – biodegradable waste is shredded, sifted and processed using static pile composting. The humus is then converted to pelletized compost.

The present disposal site is under the administrative and operational supervision of the Payatas Operations Group under the Environmental Protection and Waste Management Department. The average waste intake of the facility is about 6,078 cubic meters or 1,215 metric tons of waste per day, which is ferried by an average of 413 trucks/trips. Three (3) dumping areas are now being used in the facility:

1. New Mound – the upper dumping table of the New Mound receives around 250 truckloads a day. It could accommodate approximately 121,825 cu.m. of fresh wastes and could reach a desired height of around 95 meters, its full capacity.

2. Mondragon Dumping Table – this 3,428 sq.m. dumping area could accommodate an estimated 215,204 cu.m. of waste. It has an intake of about 180 trucks per day.

3. Old Mound – old waste deposited at the new mound is transferred to the old mound for the disposal area's soil cover. The old mound could accommodate around 157,125 cu.m. of old waste until its final capping.

The Conversion Project also improved the working condition of the more than 2,000 scavengers working at the Payatas CDF. Sorting areas were allocated to each of the eight (8) organizations working at the dumpsite and a covered centralized trading area was also provided along Amlac Road at the old dumpsite.

Eight sub-dumping tables were established to accommodate the eight organizations working at the dumpsite. A rotation system of waste picking is being implemented to establish an equal playing field for the scavengers and to further improve the collection efficiency of recyclable materials in the dumpsite. Almost all recyclable materials are being collected with this system.

3.9 Hospital, Hazardous and Industrial Wastes and Special Wastes

Hospital, Hazardous and Industrial Wastes, which are categorized as special wastes, are not collected by the City contracted haulers as it is not included in the Contract of Agreement and in the Terms of Reference set by the City. The hauling of these types of garbage is the responsibility of the hospital and the industry owners. This kind of waste is likewise not accepted at the Payatas CDF.

It is the usual practice of the residents to mix household hazardous wastes such as empty paint cans, thinners, batteries, spray canisters, light bulbs, etc. with common household waste. Although a Hazardous and Toxic and Nuclear Waste Law in the country exists, the enforcement only covers big quantities of waste such as the hazardous waste from industries and hospitals.

The absence of alternative disposal facilities for these specific types of waste and the lack of manpower are primarily the reasons why the enforcement of the law is not strictly imposed especially in residential areas.

3.10 Bulky Wastes

Collection schedule for bulky wastes is slated every last Sunday of the month following Executive Order No. 24, which declares every last Sunday of the month as Simot Basura sa Barangay Day. This system was introduced to get rid of bulky wastes like dilapidated and old furniture and appliances, tree cuttings and trimmings, getting mixed into the regular household wastes. This also intends to teach the households to segregate their wastes properly.

For almost three (3) years, this project has been implemented at no added cost to the City's constituents and the barangay. However, under the New Quezon City Revenue Code or City Ordinance No. SP-1452, S-2004, which was passed by the City Council and approved by the City Mayor on January 24, 2005, fees for the collection of bulky wastes had to be imposed. The collection of tree cuttings and other yard wastes, on the other hand, remained the responsibility of the City and is still collected every last Sunday of the month as per request of the barangay.

For the year 2005, a total of 29,662 cu.m. of bulky wastes were collected, consisting mainly of tree cuttings/trimmings. At least 114 tires were also sent to HOLCIM Philippines.

3.11 Markets for Recyclables

Junkshops operating in the City receive most of the recyclable materials recovered by individual households and the barangay. The types of recyclable materials recovered are the following:

1. Paper - newspaper, white, assorted, cardboards
2. Plastics - PET, hard plastics or *sibak*, PVC
3. Metals - tin cans or *lata*, aluminum cans or *fanta*, iron, bronze or *tanso*, yero
4. Bottles - clear, long-neck, *lapad*, *bilog*, colored, crushed or *bubog*

3.12 Markets for Compostables

Collected compostables are either processed into organic composts thru the Barangay MRF or collected by hog raisers. Organic materials that are brought to the Payatas CDF are processed into palletized humus.

Composts produced are usually sold to individual households for home landscaping and gardening. Small to medium-scale marketing is being done in barangays with composting equipment such as in the case of Barangay Phil-AM.

The agriculture industry is the largest potential market for compost although it is difficult to penetrate because of the large volume requirement of commercial buyers. Factors that affect the production and sale of compost are: the volume of compost produced by individual barangays is not enough to meet the requirements of commercial buyers, the quality of compost produced, lack of awareness on the general application of the product, difficulty in applying the material, time frame after application before the effect could be seen on the soil and product, and cultural or other biases against the use of products generated from waste.

3.13 Information, Education and Communication Campaign (IEC)

To raise the level of awareness of the public on the various environmental laws and policies implemented by the City, a massive IEC program is being implemented to achieve the widest participation and support in implementing as well as advocating projects/programs on environmental protection, more specifically on solid waste management. The following were employed to achieve this purpose:

1. Showing of cinema infomercials about Quezon City's Solid Waste Management Program entitled Clean, Clean QC in 2002.

2. Showing of advertisements and infomercials on environmental protection particularly on Reuse, Recycling and Composting in all 82 movie houses in Quezon City (VCD copy) in 2004.

3. Distribution of instructional materials to 142 barangays, 97 public elementary schools, 297 private elementary schools, 45 public high schools, 177 private high schools and 49 Health Centers within the City.

4. Hosting of "Earth Day Jam" in 2004 to 2007, a musical tribute to Mother Earth, attended by well known environmentalists, musical artists, and people from Quezon City and nearby cities.

5. Conduct of comprehensive IEC Campaign in barangays with SWM Programs as part of the implementation of separate collection or the "No Segregation, No Collection" scheme.

6. Distribution of the Honorable Mayor's open letter to business establishments in the City regarding maintenance of cleanliness in their premises.

7. Deployment of Solid Waste and Environment Education Program Coordinators (SWEEP Coordinators) in the year 2004 as lecturers and campaigners in the implementation of waste segregation and other environmental programs.

8. Deployment of IEC Campaigners provided by the City Garbage Contractors on the door-to-door collection system in inaccessible areas and other concerns about the garbage collection system of the City.

In the course of implementing these projects, the following were observed as the resulting impact of the massive IEC campaign:

- *Increased public awareness on environmental laws, ordinances and other policies as manifested by several requests for deputation as Environment Police from private citizens and several barangays expressed their willingness to be stewards of the environment.*

- *Increased awareness on the benefits of proper solid waste management, particularly waste segregation at source, as manifested by the increased number of requests from schools and establishments for the conduct of seminars on proper SWM.*

- *Awareness on the benefits of proper solid waste management resulted to the reduction of 11.45% waste volume intake at the Payatas CDF or approximately 23,422 cubic meters per month reduction from January to May 2005.*

- *Increased requests for EPWMD to provide technical assistance and guidance on swm implementation.*

- *Compliance to the No Segregation, No Collection scheme implementation increased as manifested in the reduction of truck requirement per area and consequently, an increase in the solid waste diversion in every barangay.*

- *Solid Waste Management Programs were also implemented by schools as a result of the continuous IEC campaign. Tapping the future leaders of the country would ensure continuity of efforts towards waste reduction. Also, through the different strategies employed, it was able to instill stewardship, accountability and to a certain extent, values change among the youth.*

- *Most importantly, cleaner surroundings and well-managed garbage from the households was observed.*

3.14 Costs and Revenues

Annual Budget Allocated for Calendar Year 2005: *P 828,934,342.00*

- ***Personal Services Expenses:*** ***P 5,818,614.00***

  Of the total amount allocated under this item, only about 5% was spent because only 28 positions were filled-up. The remaining personnel were hired under Contract of Service.

- ***Maintenance and other operating expenses: P 821,329,400.00***

  P 600,000,000.00 was allocated for Garbage Hauling Services. The expenses for garbage hauling was computed at P 50,000,000.00 per month for 12 months for the 5 collection districts (District I, District II-A, District II-B, District III and District IV). The amount was based on the price ceilings under the TOR set by the City Government for bidding purposes. However, the actual expenses in a month's time were lower than the ceiling price due to the imposition of fines and penalties on the Contractors for various shortcomings and deficiencies. The penalties accrue as "savings" for the City and were used for Special Operations.

  P 193,200,000.00 was allocated for the improvements that were undertaken at the Payatas Controlled Dump Facility.

  P 10,464,000.00 was allocated for the salaries of the 155 Contractual Personnel in the Department.

  P 5,050,000.00 was allocated for massive IEC-related programs (signboards, flyers, contest in schools and barangays, conduct of special events, rentals, seminars on SWM and Anti-Pollution, etc.).

P 5,000,000.00 was allocated for the Incentive Package Program given to barangays for the savings accrued through waste diversion.

P 3,850,400.00 was allocated for the annual implementation of the Sagip Batis sa QC Project or the Riverways Management Program.

P 3,565,000.00 for Advertisements on SWM.

P 200,000.00 was allocated for office equipment and repairs and maintenance of motor vehicles.

- Capital Outlay: P 1,786,328.00

P 1,386,328.00 was allocated for Other Structures - Massive Information Campaign (house to house IEC - Billboards and Flyers).

P 400,000.00 was allocated for miscellaneous expenses.

An average of P400,000.00 a year is earned from penalties paid by Environment Violators. The revenue earned from violators is low because Violators are given the option to render community service rather than pay the fine.

The City has never collected hauling service fees from residential areas. With the approval of the New Revenue Code, however, fees for the collection of bulky wastes was imposed, thereby, generating a total revenue of Php156,412.50 from February to October 2005.

3.15 Key Issues

The following are common problems and issues on solid waste management:

- *High cost to provide solid waste management services*
- *Inadequate technical manpower*
- *Lack of a permanent section or individual in the Barangay to handle solid waste management.*
- *Scarcity of site for the establishment of Barangay Materials Recovery Facility.*
- *Lack of proper documentation on the part of the barangays on their solid waste diversion.*
- *Non-cooperation of some barangays in the implementation of waste segregation at source and separate collection.*
- *Lack of discipline on the part of the residents.*
- *Uncertainty of markets for compost product.*

IV. WASTE CHARACTERISTICS

4.1 Disposed Waste *(from WACS)*

In April 2003, the Quezon City Government, thru the EPWMD conducted Waste Analysis and Characterization Study (WACS) to establish the City's waste stream data. Results of the study showed that the average volume of waste disposed at the Payatas CDF averaged at 6,157.47 cu.m./day or 1,293 tons/day. Per capita generation is about 0.66 kgs/person/day while the over-all waste density is 210 kgs/cu.m.

Table 11. Waste Analysis and Characterization Study

Type of Waste	Percentage (%)	Quantities	
		tons/day	Kg/day
Biodegradable Waste	48	620.67	620,673
▪ Food/Kitchen Waste	39	504.30	504,297
▪ Garden Waste	7	90.51	90,515
▪ Others (animal remains, human waste, fines)	2	25.86	25,861
Paper	17	219.82	219,822
Plastic	16	206.89	206,891
Glass / Bottle	3	38.79	38,792
Metal	3	38.79	38,792
Residual Waste	13	168.10	168,099
TOTAL	**100**	**1,293.07**	**1,293,069**

4.2 Diverted Waste

Of the total volume of waste generated by the City per day, the total waste diverted by the barangays and the junkshops is about 488.45 tons/day or 29.76%.

Table 12. Waste Quantity Diverted from Different Sources

Source	Diverted Waste (tons/day)	Percentage
Diversion of Barangays with SWM Program	12.50	0.76
Diversion of Junkshops	474.62	28.92
Kitchen Waste Diversion	1.33	0.08
TOTAL	**488.45**	**29.76**

Aside from the Barangays, the EPWMD has acknowledged the vital contribution of the City's junk dealers and traders to the City's waste diversion campaign. An estimated 341 junkshops are currently operating in 73 barangays in Quezon City. Based on survey conducted by the EPWMD in August 2005, 28.92% of the City's daily waste volume that would have ended in Payatas is traded instead by these junkshops. This volume alone accounts for 97% of the mandatory 25% waste diversion target required under R.A. 9003.

Hence, the EPWMD is seeking to improve the operations of junkshops, and thereby make them more efficient, law compliant, and environment friendly. Also in August 2005, a Junkshop Standardization Program was started, which aims to get the active participation of junkshop operators in the waste reduction campaign of the City.

4.3 Generated Waste

Based on the conducted Waste Analysis and Characterization Study (WACS) in 2003, waste generation is about 0.66 kgs/person/day, computed on a 2% increase in the per capita generation, the waste generation per capita per day in 2005 is approximately 0.69kgs./person/day. Multiplying this with the estimated 2005 population of 2,392,701, the City's total generation is about 1,650,963.69 kgs./day or 1,650.96 tons/day.

V. LEGAL/ INSTITUTIONAL FRAMEWORK

5.1 Local Laws and Regulations

Table 13. City Ordinances Related to Solid Waste Management

Ordinance No.	Description
1530, S-2005	Mandates residents, owners, and operators of institutions and establishments to clean their surroundings, including canals, streets, or roads, and their immediate premises to make Quezon City a cleaner and healthier place to live-in; provides penalties for violators.
1512, S-2005	Creates the Solid Waste Management Board.
1506, S-2005	Amends ordinances #6305, S-65, which prohibits the throwing of any kind of garbage, waste, or any refuse in any drainage outlets such as rivers, creeks, or any tributaries in Quezon City.
1483, S-2005	Requires all residents and business establishments in Quezon City to segregate spent fluorescent light bulbs from common garbage so as to eliminate exposure to mercury, an declares such garbage as hazardous waste.
1323, S-2003	Adopts guidelines and procedures for a unified approach to Solid Waste Management.
1203, S-2002	Gives incentives to barangays practicing best solid waste management.
1191, S-2001	Provides incentives to barangays using their own trucks for solid waste collection service in their respective barangays.
1009, S-2001	Requires the Barangay Councils of Quezon City to establish and operate ecological recycling and composting centers as part of their respective Solid Waste Management Program before the end of 2001, and as a component thereof, to purchase and operate at least two (2) composting and shredding machines, and mandating that funds be taken from the local government equalization funds and their respective allocation of the waste management fund.

Ordinance No.	Description
982, S-2000	Creates the Quezon City Environmental Protection and Waste Management Department, and provides for its organizational structure and functions, as well as funds for its operation.
941, S-2000	Regulates the operation of ambulant/push cart junk dealers and providing penalties for violation thereof.
156, S-2000	Provides for the implementation of a zero-waste resource management system or ecological waste management system through the recycling of domestic waste and encouraging all residents, schools, universities, colleges, and other similar institutions, both private and public , commercial and industrial establishments to implement sorting of domestic waste at source and separating biodegradable and compostable waste from non-biodegradable, non-compostable factory returnable.
813, S-99	Imposes a city garbage collection service charge on all persons engaged in all forms of business activities/calling or undertaking.
111, S-93	Requires all industrial and commercial establishments to provide adequate, sufficient and covered trash receptacles within the vicinity of their establishments; provides penalties for violations.
106, S-89	Requires all owners of land, business establishments and residential houses, and lessors thereof, to keep their premises clean; provides penalties for violations.
9820, S-73	Regulates Solid Waste Management and Disposal Practices, including prohibition of open dumping on vacant lots, in esteros and other courses.

❖ *Enforcement and Compliance*

To ensure that the City's solid waste management programs are widely implemented and followed, several laws and ordinances were passed and enforced. These ordinances included mandating of residents, owners and operators of institutions to clean their *surroundings and prohibiting the throwing of waste in any drainage outlet and/or waterways.*

The Environmental Enforcement and Inspection Section (EEIS) of the EPWMD employed and deputized 33 Environment Police (EP) to ensure compliance to the laws. The EP does continuous roving, fix positioning and night operations. When apprehended, violators may opt to either pay the corresponding fine or render community service.

Environmental Police, stationed in strategic areas, apprehend individuals violating the City's laws and ordinances. This strategy aims to keep the surroundings clean at all times, implement programs and projects for the promotion and safeguarding of the health and sanitation of the City, as well as enhance ecological balance thru the prevention, control and abatement of environmental pollution.

Complaints on open burning, illegal dumping and the like are also being attended to by the EPs.

5.2 Roles

The provisions of RA 9003 clearly defined the role of the City and Barangay, and the involvement of the civil society for integrated solutions on waste management. In addition to this, the City set the following requirements that will help sustain the SWM plan for the City:

- ***Responsibilities of the Residential Sector** - The Residents shall provide their respective storage receptacle for at least four (4) types of solid waste (biodegradable, recyclable, special waste & residual). If possible, composting of biodegradable waste must be done at source. Waste shall be brought out only during collection day by the City or by the Barangay.*

- ***Responsibilities of the Barangay*** - The Barangay with established MRF shall be responsible for the collection of segregated. Processing of waste shall be done in the MRF prior to the collection of the City contracted waste haulers. The Barangay shall set the guidelines in the storage and collection of waste. As such, the Barangay shall prepare its own SWM plan in accordance with the plans set by the City.

- ***Responsibilities of the City*** - The City will be responsible for the efficient collection of waste and shall provide regular collection schedule. For barangays with established MRF, the City shall only collect the residual and bulky wastes (tree cuttings/yard waste) as provided under Section 10 of RA 9003. To encourage the barangay to perform well in SWM, the City grants incentives to barangays with best solid waste management practices and to those barangays utilizing their own garbage trucks for the collection of garbage in their respective area.

5.3 City Solid Waste Management Board

The Quezon City Solid Waste Management Board has been created thru Ordinance No. SP-1512, S-2005, identifying all the key members and their duties. The Board convened in the first quarter of 2005 to discuss and finalize all the components of the Plan and to direct the implementation of the same.

Pursuant to and consistent with Section 12 of RA 9003, the following are the composition of the Board:

Chairman : City Mayor

Vice Chairman : Chairman of the Committee on Environment and Ecology

Members : President of the Association of Barangay Captains of Quezon City or his representative

Chairperson of the Sangguniang Kabataan Federation of Quezon City

One (1) representative each from the following QC Office:

a) Environmental Protection and Waste Management Department (EPWMD)
b) City Planning and Development Office (CPDO)
c) City Engineer's Office (CEO)
d) City Health Office (CHO)
e) Philippine National Police
f) Schools Division Superintendent of the Division of City Schools of DECS
g) DTI Representative
h) One (1) representative of the non-government and civic organizations from each District of Quezon City whose principal purpose is to promote recycling and the protection of air and water quality
i) One (1) private sector representative of the recycling industry
j) One (1) private sector representative of the manufacturing or packaging industry

5.4 Barangay Solid Waste Management Committees

Pursuant to Section 6, Rule 6 of DENR Administrative Order No. 2001-34, S-2001, also known as the Implementing Rules and

Regulation of RA 9003, there shall be a creation of Barangay Solid Waste Management Committee in every Barangay which shall have the following functions and responsibilities:

a) Formulate a solid waste management program consistent with the City/ Municipality Plan
b) Segregation and collection of biodegradable, compostable, reusable wastes
c) Establish materials recovery facility
d) Allocate barangay funds; look for sources of funds
e) Organize core coordinators
f) Submit monthly report to City or Municipality

Section 7.Membership of the Barangay Solid Waste Management Committee - The Barangay SWM Committee shall be composed of the Barangay Captain as Chair with the following as members:

a) One (1) Kagawad
b) SK Chair
c) Presidents of Home Owners Association
d) Public/private school principals or representative
e) One (1) Parents and Teachers Association president or representative
f) One (1) Religious organization representative
g) One (1) Bus community representative
h) One (1) environmental NGO representative
i) President of Market Vendors Association; One (1) representative from junkshop owners' association

The City passed an Executive Order requiring all Barangays to form their respective Solid Waste Management Committees and submit the same to the City.

5.5 Stakeholders Participation

Presently, the level of awareness of the Quezon City residents regarding Republic Act 9003 and some of its important provisions like the mandatory segregation of waste at source is high however; compliance to the law is quite low.

To increase the level of compliance, information and education campaign shall be continuously undertaken at the community level through Barangay initiatives. To ensure participation of all stakeholders, house to house inspections on proper waste segregation will be conducted by the Barangay regularly.

To determine the level of participation by the Stakeholders, surveys/questionnaires will be designed for them to accomplish. The accomplished questionnaire will be used for future planning and strategies.

VI. PLAN STRATEGY

6.1 Vision

The vision of EPWMD is for Quezon City to be:

a) *A model city where all of its barangays are practicing waste segregation at source and segregated collection;*

b) *A city with a model disposal facility where solid wastes are processed and converted to other useable resources;*

c) *A city where solid waste avoidance and volume reduction is commonly practiced by the general public;*

d) *A city where only residual waste are being collected by the City Contracted Haulers; and,*

e) *A city where residents and transients comply with environmental laws and policies.*

As prescribed in the provisions of R.A. 9003, the Quezon City Government through the EPWMD prepared a ten (10) year plan that will guide the City in the implementation of activities and programs, primarily on the protection of the environment and proper waste reduction and disposal.

Quezon City being a first class and highly urbanized city aims to be a model city where all of its barangays are practicing segregation at source and segregated collection. This is attainable and sustainable because the City has already mandated all of its Barangays to practice segregation and has provided sufficient funds for operating costs and materials and other provisions for sustainable development. Further, incentives *were also given to Barangays that have decreased their solid waste collection cost.*

In the manner of dumpsite operation and utilization, the continuous repairing and rehabilitation of the Payatas CDF ensured the prolongation of its lifespan. Another plan is to develop the site for the extraction of methane gas for conversion into electrical energy. Proper coordination with private sector and national government agencies is on-going.

The programs of the City aims to achieve its goals relevant with environmental protection and waste management and at the same time alleviate the economic condition of the people.

- *The Basura Hiwa-hiwalay Na! program is a current program which will be improved and named Sinop Basura sa Barangay Program. It aims to divert the waste by means of recovering recyclables at source and converting biodegradables into compost. Thus, only residual waste shall be collected under the door-to-door concept of waste collection.*
- *Sagip Batis sa Q.C. is a micro project of Riverways Sanitation Services. The 1,000 volunteers from 101 barangays nearest the city's rivers and creeks assisted in the cleaning, clearing of the waterways and monitoring thereafter.*
- *Special Cleaning and Clearing Operations Group is the by-product of the Street Cleaning Services. Its function is to clear and clean any public place and other areas, remove and level earth mounds on side streets and sidewalks, grass cutting and clearing, removal of streamers advertisement boards and other eyesores.*

6.2 Targets

In compliance with the requirement set forth and provided by the law, the City will establish mandatory waste diversion programs through re-use, recycling, composting and other resource recovery activities. Twenty-five percent of the waste volume shall be diverted before reaching the disposal facility.

Table 14. Projected Waste Diversion and Disposal Targets

Year	Vol of Waste Gen/ Capita/ day with Increase of 2%/ annum based on WACS	Projected Population with 1.92% Growth Rate	Daily Waste Gen Based on Population (ton)	Waste Diver-sion Target (%)	Volume to be Diverted (ton)	Target Resi-dual (%)	Target Disposal Volume (ton)	WACS	
								Bio (48%)	Recy-clable (39%)
2005	0.69	2,392,701	1,651.00	20	330.19	80	1,320.77	792,463	643,876
2006	0.70	2,438,591	1,716.28	25	429.07	75	1,287.21	823,815	669,349
2007	0.72	2,485,379	1,784.19	29	517.41	71	1,266.77	856,413	695,836
2008	0.73	2,533,063	1,854.79	33	612.08	67	1,242.71	890,301	723,370
2009	0.75	2,581,658	1,928.18	37	713.42	63	1,214.75	925,528	751,992
2010	0.76	2,631,188	2,004.48	41	821.83	59	1,182.64	962,151	781,747
2011	0.78	2,681,669	2,083.79	45	937.70	55	1,146.08	1,000,222	812,681
2012	0.79	2,733,120	2,166.25	49	1,061.46	51	1,104.78	1,039,801	844,838
2013	0.81	2,785,558	2,251.97	53	1,193.54	47	1,058.42	1,080,946	878,268
2014	0.82	2,839,003	2,341.08	57	1,334.41	43	1,006.66	1,123,719	913,022

6.3 Strategies

Solid waste volume reduction through composting, recycling and other modes of waste recovery is the key in order to reduce the quantity of waste being collected and disposed at the Payatas CDF. The Waste Analysis and Characterization Study (WACS) conducted by the Environmental Protection and Waste Management Department from April to May 2003 revealed that about 6,157 m³ per day (1,292.97 TPD) of waste are disposed at the Payatas CDF. The bulk of this waste, which is about 3,631 m³ per day (762.51 TPD) or 59% of the total quantity, comes from the residential areas. This being the case, the main strategy of this plan will focus on the residential areas/household levels.

Basically, the strategy involves the constitution and activation of the Barangay Solid Waste Management Committees that will take charge of the solid waste management of their respective barangay in coordination with EPWMD. This is in compliance with Section 6, Rule VI of the Implementing Rules and Regulations of RA 9003.

6.3.1 General Description of Coordination with Barangays to Implement Segregated Collection, MRFs and Composting Facilities

Intensive IEC campaign on laws, ordinances and programs shall be done in every Barangay to inculcate in every individual the importance of proper waste management. Further, imposition of fines and penalties shall be implemented to those who fail or would not want to comply. Also, the No Segregation, No Collection scheme shall be practiced.

Compliance to the segregation at source shall promote the establishment of a MRF and effectively encourage the residents to participate in the program and thus, see its benefits and sustainability.

6.3.2 General Description of Collection and Transfer

- **Macro-micro Cell Route Collection Scheme** is the system of waste collection dividing the City into districts and the districts by Barangays, further subdividing the Barangays into cells; One (1) cell route is equal to one (1) unit collection vehicle, the model and classification or type of which is dictated by the demographic or topographic condition of the cell route area, the vehicular movement and other situation which will hamper and obstruct its activity.

- **Barangay Base SWM Collection Operations.** The Barangay is subdivided into cell or route and by main roads. Frequency of

Barangay cell based waste collection operation is two (2) times weekly, 7:00 AM TO 4:00 PM.

- **Main Road Cell Route Collection** – per district collection is continuous and contiguous within the given district and not bounded by Barangay. Frequency of collection is daily and regularly at 4:00 AM to 7:00 AM and mopping up between 10:00 AM to 2:00 PM and followed by 5:00 PM to 6:00 PM.

- **Stationary and Institutional Domestic Waste Cell Collection** – Serving government offices, hospitals, academe, markets and other agencies. Collection is three (3) times weekly at 7:00 AM to 4:00 PM.

The system of garbage collection, transport and disposal operations is on a per trip basis and which the City directly administers, manages, and supervises. The City aims to convert the current service contract to full privatization. A term of reference (TOR) for the service contractor to follow shall be included and bidding will be conducted. The City through the EPWMD will be handling the administrative function, which includes monitoring. Modernization of heavy and light equipment shall be pursued.

6.3.3 Overview of Plans for Disposal

To prolong the use of the Payatas CDF for another five (5) years, it was rehabilitated and converted into a controlled disposal facility (CDF). Extraction of old waste for transport and disposal to Rodriguez CDF to reduce the height was implemented in 2002 – 2003 simultaneous with the laying of at least two (2) meters thick topsoil. From 2003 to 2005 the repairs, rehabilitation, conversion and operation of a CDF was carried out including the extraction of methane gas. In 2006 and prior to its closure, A Closure Plan was submitted for approval to the Environmental Management

Bureau – National Capital Region (EMB-NCR). A contingency for the utilization of an alternate sanitary landfill will be prepared as part of the ten (10) year plan.

6.3.4 Discussion of Other Key Elements of Strategy

To sustain the practice on waste reduction and diversion in the barangay, the City implemented the validation scheme once a month in implementing barangays. The volume of waste reduced by means of composting and recycling in the barangays was documented. Junkshop buying and selling of recyclable materials is also monitored. Junkshops will be required to provide data on volume of recyclables bought and sold. The City through the EPWMD shall standardize the operating system of all existing junkshops doing business in the City.

The City shall likewise coordinate and participate with other government agencies and private sector on programs and projects related to solid waste management.

VII. SWM SYSTEM

7.1 Source Reduction

Section 20 of RA 9003 states that "Each LGU plan shall include an implementation schedule which shows that within five (5) years after the effectivity of the Act, the LGU shall divert at least 25% of all solid waste from waste disposal facilities through re-use, recycling, composting and other resource recovery activities, provided that, the waste diversion goal shall be increased 25% every three (3) years thereafter.

The waste diversion targets have been discussed earlier at section 6.2. This program shall target all residents of Quezon City, commercial, and institutional sectors. Diversion rate shall be computed from the volume of recyclable and compostable materials that have been removed from the waste stream. Each barangay with MRF shall maintain a record of the recyclable materials and compostables that have been collected. Likewise, each barangay shall monitor and get a record of all recyclables that was bought and sold from junkshops within their area of jurisdiction.

7.1.1 Capability and Economic Viability of the City in Implementing the Program for this Component

The City aims to improve the SW system by means of professionalizing work activities of the personnel involved and the standard administrative policy. Personnel involved in the garbage collection services will be appointed in a permanent position under the Regular Plantilla System, while those who could not be given or unable to acquire a permanent position shall be under the job contract basis with higher salaries commensurate to their respective competency, efficiency and ability to handle multiple tasks. Once the personnel have been adequately compensated, it can attain an efficient and responsible workmanship. Continuous capability building, technical trainings and knowledge enhancement shall be provided to boost effectiveness of the employee.

The EPWMD, the implementing department of the City has a regular approved budget for the implementation of the solid waste programs.

7.1.2 Technical Requirements for the Ordinances and Other Formal Actions to be taken by the City

To encourage widest participation of the community in the implementation of the plans and programs on solid waste management, the City Council passed two (2) Ordinances granting incentives to the barangays in December 2002.

1. **Ordinance No. SP-1203, Series of 2002** – An Ordinace granting incentives to barangays practicing best solid waste management. This Ordinance provides for an incentive package scheme that applies to all barangays that meet the following criteria set by the City Government:

    - ✓ A comprehensive solid waste management plan must be prepared by the barangay and duly approved by the City through the EPWMD.

    - ✓ The barangay should have been practicing best solid waste management for at least six (6) months and must have achieved at least 25% volume reduction of its solid waste.

    - ✓ The barangay has an ecological or recycling center or MRF.

The barangay shall receive an incentive package equivalent to 50% of the savings they have made based on the computation of the EPWMD as stipulated in the Ordinance.

2. **Ordinance No. SP-1191, Series of 2001** – An Ordinance providing incentives to all barangays utilizing their own trucks for solid waste collection service. This incentive package applies to all barangays that meet all the criteria set forth in the ordinance.

- ✓ The barangay is the registered owner of the collection truck.
- ✓ The area being collected must not be collected by the City's contracted hauling trucks.
- ✓ The collected waste must be dumped at the Payatas CDF or any other mandated disposal facility by the City.
- ✓ All trips made by the barangay truck must be supported by trip tickets that are patterned after the Garbage Collection Trip Report Form (EPWMD Form 1) being utilized by the City.
- ✓ The barangay must keep a record of the waste collection services of their truck.

The barangay shall receive an incentive package equivalent to the amount corresponding to the number of trips made by the barangay truck, provided that the actual trips made by the truck do not exceed the estimated truck requirements. The basis of computation and conditions on the granting of the incentive package are provided in the Ordinance.

7.1.3 Social Impacts on Stakeholders Involved or Affected

- *Increase per capita earning derive from the sales of recyclables*
- *Lesser per capita expenditures on food costs derived from backyard farming*
- *Lesser volume of waste to dispose*
- *Lesser cost on per capita solid waste management collection and disposal*
- *Granting of incentives*
- *Cleaner and healthier environment*
- *Aesthetic effect*

7.2 Collection

Basically, the strategy for collection shall involve the constitution and activation of the Barangay Solid Waste Management Committees that will take charge of the solid waste management of their respective barangay in coordination with EPWMD. Each barangay shall then be required to impose segregation at source and the recyclables and compostables shall be collected by the barangay eco-aides. This is in compliance with Section 6, Rule VI of the Implementing Rules and Regulations of RA 9003. These collected recyclables and compostables shall be brought to the MRF for further segregation and composting.

The residuals shall be collected by the City Hauler using the Package Clean-Up System of garbage collection, wherein the contractor is given full responsibility to manage, administer and directly carry out the actual collection, cleaning and disposal of waste from various sources. However, the same shall be practiced by barangays with collection trucks.

7.2.1 Overview

7.2.1.1 Description of the Strategy for Collection, based on the Projected Quantities of Segregated Biodegradables, Recyclables and Residual Wastes

In compliance with Section 6, Rule VI of the Implementing Rules and Regulations of RA 9003, collection of solid wastes shall be segregated. The Barangays shall identify the type of collection vehicles that shall be needed depending on the volume of segregated waste to be collected.

7.2.1.2 Description of Collection Process for Each Type of Waste

Barangays shall provide a schedule on the collection of biodegradables and non-biodegradable waste to impose the segregated collection scheme. All wastes that will not be collected by the barangays shall be regarded as residual wastes.

7.2.1.3 Types of Collection Vehicles, Collection Frequency, Collection Points, and Types of Containers

Variable types of vehicles ranging from heavy 10-wheeler dumptruck with capacity of between 16 cubic meters to 18 cubic meters, heavy 6-wheeler dumptruck with capacity of between 10 cubic meters to 12 cubic meters light 6-wheeler dumptruck with capacity of between 5 cubic meters to 6 cubic meters shall be utilized.

There shall be daily collection of segregated wastes along the main thoroughfares. A twice a week collection shall be instituted for barangay/community and households or residences. For stationary sources like markets, government offices and other institutional entities, a three times a weekly collection shall be provided. Further, for bulky and yard wastes generated within the barangay, a once a month collection scheme shall be utilized. In cases of excessive waste generated because of social activities or natural calamities, additional dumptrucks shall be allocated.

Door to door collection of solid waste shall still be utilized on accessible areas. However, for inaccessible areas, push carts shall be used.

7.2.1.4 Entity Responsible for Providing Collection foe Each Type of Wastes and for each Sector

As mandated by the RA 9003, the City (EPWMD) through the City Privatized Contracted Garbage Haulers shall handle the collection of residual wastes coming from households/barangays. Private haulers shall collect from the main thoroughfares and stationary sources. In residential areas, collection shall be the responsibility of the barangay except for residual wastes.

7.2.2 Collection equipment and routes

The volume of waste coming out of Metro Manila's largest city will basically be collected by the five (5) private haulers signed-up by EPWMD. Each truck shall be issued a work assignment ticket daily and then proceed to collect from their assigned cell route.

For inaccessible areas, the "door-to-door" system shall be employed using the "kariton". Two pushcarts pushed by paleros shall alternate in collecting garbage in the inaccessible areas. When one of the pushcarts is already full, it shall be loaded into a waiting dump truck on the main road.

7.2.3 Private collection service

7.2.3.1 Collection Service by Private Haulers

Through the **Package Clean-Up System** which combines the efforts of the EPWMD, private haulers, and the community, Quezon City has been able to keep garbage off its streets. Thus, this system will still be employed by the city government.

At 3:30 AM, several dump trucks – each bearing a crew of two paleros, a driver, and a SWEEP coordinator – start to roll out of the dispatching area of the private contractor. The trucks are issued a Work Assignment Ticket (WAT) and instructed to proceed to their designated routes. From 4:00 to 6:00 AM, they hit the main roads, picking up garbage from shops, offices, and other establishments located along the major thoroughfares. At 7:00 AM, the trucks fan out to the barangays. Collection at each barangay takes an average of three to four hours, but given the number of barangays, the whole routine winds up way past noon.

Meanwhile, at around 9:00 AM the private hauler shall conduct the first mopping-up operations for the day. The second is scheduled at 2:00 PM and the last one at 6:00 PM. Mobile monitors shall go around continually and when they spot uncollected garbage, this is reported by radio to the operations supervisor. Uncollected garbage shall be picked-up during the mopping operations. By 5:00 PM the last collection truck shall already be en route to Payatas CDF to unload their haul. All trucks are back at the dispatching area by 6:00 or 7:00 PM.

7.2.3.2 Service Areas

Each district has been divided into "route cells". A route cell corresponds to an area of variable size which generates 16 cubic meters, or one truckload of garbage. The number of trucks deployed to any given area, along with the frequency of collection, is determined by the number and type of cells found therein. Main road cells refer to cells located along major roads, at which collection is done daily. Stationary cells are markets, hospitals, and schools that are owned and/or operated by the national or local government. Garbage at these cells are picked-up daily or two to three times a week, depending on the volume. Barangay cells are found in residential areas and are serviced twice weekly.

This system allows the City government to determine exactly how many trucks are needed each day to collect the garbage; it facilitates the coding of service areas; and provides a rational basis for scheduling collection.

7.2.3.3 Basic Terms of Contract

Contractors under the Package Clean-Up System are paid on the basis of the computed hauling requirements of their assigned routes. If a particular route has been determined to require, say, two trucks, the contractor is paid for the use of two trucks even if he shall actually deploy more, as happens in mopping up operations or when, for one reason or another, garbage has been left uncollected.

This arrangement forces contractors to make their operations efficient because the City wouldn't pay for any extra trip.

7.2.4 Storage and setout

Segregated wastes can be placed in any container provided they are well segregated.

7.3 Segregation, Recycling, and Composting

The City's EPWMD shall introduce the "Sinop Basura sa Barangay" Program. This program aims to encourage the practice of waste segregation and recycling by implementing a "No Segregation, No Collection" scheme.

A project coordinator from the EPWMD shall go around and help the barangay to organize its SWMC, and to agree on a plan to manage its solid waste. Soon after, the barangays SWMC, shall start a zone-by-zone information drive to explain the new garbage collection scheme to the residents.

While this is on-going, the EPWMD project coordinator shall conduct a Solid Waste Perception Survey- an inventory of the amount and type of waste being generated by the barangay. The next step shall be a dry-run to check if the residents are segregating their waste. This involves actual house-to-house collection of waste, preceded by a close inspection of the contents of garbage bags.

Recyclables shall be collected by the eco-aides once a week. Eco-aides shall carry a checklist and note down which household surrendered their recyclables.

Biodegradables shall be grouped into two types, with their respective modes of disposal. Food or kitchen waste that can be fed to hogs is gathered from house to house by a designated collector. Other biodegradable wastes shall be brought by individual households to the barangay composting area, which shall be managed by workers paid by the barangay.

The city contracted hauling trucks which are supposed to collect only residual waste shall go to the barangays only once a week.

7.3.1 Marketing

- The market for recyclables are the junkshops organized by the City. Compost shall be sold to residents or private garden contractors. For barangays with large vacant area, the compost shall be used for their urban garden and organic vegetable production.

- Livelihood from recyclables shall also be introduced to the barangay like bag making, decorative items, place mats, etc. from paper, plastics, doy packs, aluminum, etc.

- Tile making from residual wastes shall also be introduced. The tiles could be used by green contractors for pavement, decoration and the like.

- A trading center for recyclable materials has been set-up in the Payatas CDF to facilitate the trading activities of more than 2,000 scavengers working in the dumpsite. This system shall continue up to the final closure of the CDF.

7.4 Transfer (if applicable)

With the existing disposal facility, there is no need to utilize a transfer station. The proximity of the Payatas CDF does not compel the City's waste collectors to even establish a stationary collection point within the collection areas. The existing and the future construction in the re-engineered design of the Payatas

CDF will result to a better capability and stability of the site. It can receive a minimum 1,300 tons to 1,000 tons daily within the scheduled time.

In case a situation occurs when there will be a need to utilize other disposal facilities like the Clark Development Sanitary Landfill in Tarlac or the Rodriguez Sanitary Landfill, the Payatas CDF shall be used as a transfer station. The area opposite the old mound is proposed to be the site of the transfer station. It is about 1,500 square meters and can easily accommodate an estimate of 500 tons of waste or more than 15 units of 10 wheelers at one given time for re-hauling and for three (3) units payloader maneuvering and operating in a triangular area and its manner of loading.

A 10 X 10 meter long ramp shall serve as a tipping table for the incoming big and mini trucks. The City shall grant additional fuel rate to private haulers that will use a direct and shortest route to the nearest available landfill.

The operational plan in the use of the Payatas CDF as transfer station is for the immediate and prompt movement for deployment of 5 units payloader and the provisions of 20 units' 10 wheeler trucks with 25 cubic meter capacity load per service contractor to be used in transporting the waste to the nearest sanitary landfill. A mini-transfer station in each of the districts shall also be instituted if necessary. While this takes place, the Payatas Operations Group (POG) will prepare a 2,000 square meter area in the new mound or other area in the CDF to serve as the transfer station and an adjacent area for recycling and sorting area. Final sorting will be conducted for incoming waste to be able to collect recyclable materials and the residual wastes transferred to the designated station for final loading and disposal.

7.5 Disposal

7.5.1 SW Disposal Capacity

The average solid waste disposed for year 2004 in the Payatas CDF is about 1,337 metric tons of waste per day being transported by an average of 418 trucks/trips. Three (3) sites within the facility is currently being used. The acquisition of two (2) more properties adjacent to the site will extend the use of the Payatas facility by another two (2) years after 2006. However, national regulation mandates the closure of all controlled disposal facilities by year ending 2006.

Based on the Waste Analysis and Characterization Study (WACS) made by the JICA in 1997 and the WACS undertaken by the City in 2003, the waste generation per capita increases by 2% annually. On the other hand, population annual growth rate of the City is 1.92% based on the National Statistics Office (NSO).

Analysis of the above data revealed that in year 2002 population count is 2,258,107 and could reach to about 2,839,003 by year 2014. Computed waste generation rates, on the other hand, is projected to increase from 1,320.32 tons daily to 2,341.08 tons daily in 2014 if segregation will not be implemented because by then the per capita volume is 0.82 kg/day.

With the City's efforts on continuous implementation of waste reduction programs and provision of funding assistance for materials and equipment to the barangays, it is certain that mandated waste diversion rate shall be achieved by the year ending 2006 and may even exceed the target of 50% by the year ending 2011.

At present, the City has exceeded the 25% target and attained a higher rate and volume of diversion for year 2006. It is assumed that a 0.5% unrecorded diversion was met directly from the effort of some barangays and NGOs under the ***Basura Hiwa-hiwalay Na! Program*** which started in 1999. Another 14% have been collected by ***Linis Ganda*** in their buying of recyclables. Both initiatives, the Basura Hiwa-hiwalay Na Program and the Linis Ganda Project have diverted waste from the current waste stream by 19%.

Moreover, within the Payatas Disposal Facility, about 2,000 waste pickers belonging to eight (8) organizations are working by sorting and collecting recyclables from the waste disposed in the site. It can be safely assumed that these waste pickers earns about PhP150 to PhP200 per day representing the collected recyclables of at least about ten (10) kilogram per day from the dumped waste, translating into a 20 ton reduction per day. Based on records from the above-mentioned organizations, the City may have been reducing the total waste generated by 18%. Further, efforts of the more than 300 existing junk dealers that are all non-members of the Linis Ganda situated in various parts of the City is also being looked at.

The total remaining waste that has to be deposited in the Payatas Controlled Disposal Facility is estimated to be about 1,046.52 tons that is regarded as residual wastes. This is about 5,232.6 cubic meters of waste spread over the more than seven (7) hectares of the available space of the said disposal facility.

Sustaining the implementation of the waste diversion programs will secure the City's low volume of waste disposal until after 2014. The City's SWM Department will continuously monitor and validate the programs and activities in the communities. Further, the City shall continue to look for other approaches and techniques to address residual wastes that can be converted into other products that can be of use by the community.

In terms of comparing existing disposal capacity with the capacity requirements, the plan of expanding the existing facility would be put on hold should the efforts on waste reduction together with the participation of the community and the other sectors be sustained.

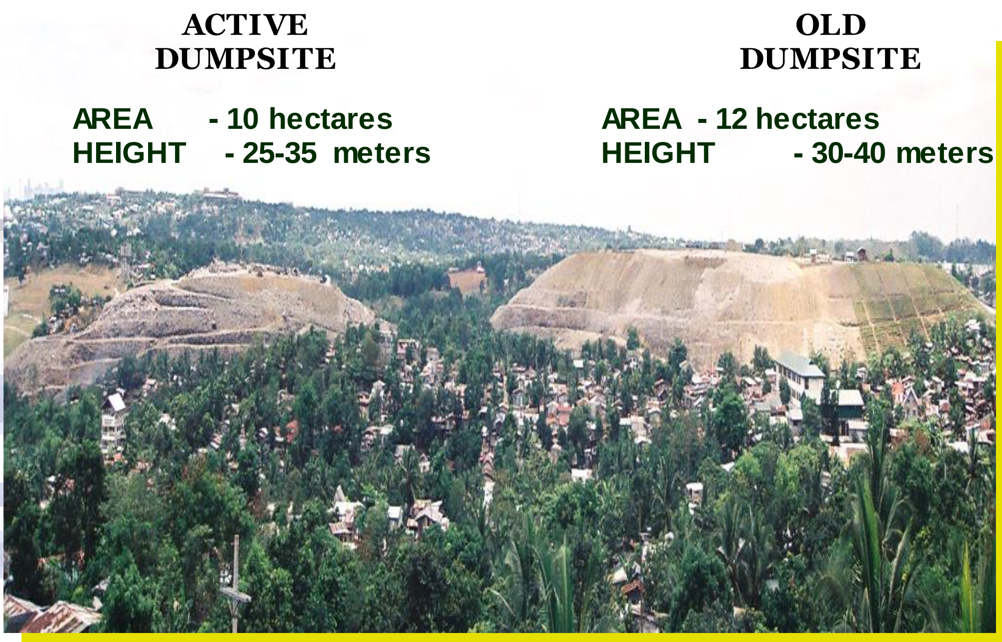
7.5.2 Existing Facilities

Payatas Controlled Disposal Facility (Payatas CDF)

The Payatas Dumpsite, the biggest and the oldest operating dumpsite in Metro Manila, has been Quezon City's disposal facility for more than three (3) decades. Through the Payatas Operations Group (POG), and the support and cooperation of the Barangay, various organizations and the IPM Environmental Services, Inc. (IPM-ESI), in association with Sinclair Knights Merz, Inc., the dumpsite was converted into a Controlled Disposal Facility in 2004.

Quezon City, with a per capita waste generation rate of 0.69 kilograms per person per day, the City's population generates around 1,650,964 tons of waste daily. This volume, collected by five (5) City commissioned contractors through the cell based Package Clean-up Collection System, wherein private contractors are conferred the full responsibility of managing/administering and directly implementing the solid waste collection, cleaning and disposal services, is disposed in Payatas CDF.

The Quezon City CDF occupies almost 22 hectares of land with two (2) main waste mounds: the old dumpsite, 30 - 40 meters high, has an almost 12 hectares base and the active dumpsite, 25 - 35 meters high, is sitting in an approximately 10 hectares area. The total volume of waste already deposited in the area as of 2005 is estimated at around 4.36 million cubic meters.



Waste received at the dumpsite is 39% recyclables and 61% non-recyclable. Recyclable materials vary from plastics, iron, aluminum, glass and paper materials.

Operating 24-hours daily, seven (7) days a week, the facility receives an average of almost 500 trucks per day from 4:00 AM to 9:00 PM, the allowed disposal period. Peak hours are between 6:00 to 7:00 AM and 1:00 to 2:00 PM.

There are approximately 1, 117 families living in communities immediately adjacent to the CDF. The Payatas CDF is a source of livelihood to more than 3,000 scavengers who are members of the 14 scavenger associations in the area.

Payatas Controlled Disposal Facility Operation

All incoming garbage trucks are checked at the entry point in-front of the POG office for their dumping pass and other requirements as stipulated in the haulers contract. The details of the trip are recorded in the computer at the monitoring office.

The trucks then proceed to the dumping area and are guided by the IPM-ESI/POG personnel (Tumbador) to the dumping table which is divided into eight (8) sub-dumping areas, with each area assigned to a particular scavenger association. The trucks tip their hauled waste on these designated dumping areas and each scavenger group is allowed 20 - 30 minutes to pick on the waste for recyclables and other materials with value to them. With this system, fighting among scavengers is avoided and the scavengers' efficiency in the recovery of recyclables significantly increased.

The residual wastes are pushed, leveled and compacted within the dumping table and sprayed with enzymes to control odor and at the same time hasten decomposition.

Measures for Safety Closure and Rehabilitation

- *Re-profile the waste mounds to achieve a 1:2.5 slope initially, which then settles over time to approximately 1:3 slope*
- *Incorporate appropriate benching*
- *Place approximately 600 mm of final soil cover*
- *Plant the compacted soil with Vetiver grass and other shrub species*
- *Construction of power plant at the top of the old mound*
- *Construction of vertical risers and the horizontal pipe lines for the gas collection system*
- *Construction of the nursery for the greening of the CDF at the top of the old mound*
- *Relocation of squatters at the top of the Bgy. Singit earthen mound prior to the reprofiling of the southern side of the new waste mound*
- *Increase the height of both the old and new waste mound to the designed level*
- *Connect the two (2) waste mounds*
- *Removal of the earthen mound at Bgy. Singit to a level roughly equal to the Filinvest internal road*
- *Relocation of the creek some 20 - 30 meters to the south, the distance depending upon the location of the creek at that particular section, to abut the buffer*
- *Development of the perimeter road and associated local drainage*
- *Installation of the leachate collection system*
- *Installation of the perimeter fence*

Final Closure and Rehabilitation Plan

1. Mondragon Dumping Table

The acquired 3,000 sq.m. part of the Mondragon is almost at the same level as the new garbage mound and already at the designed slope of 23°. Remediation in this area started in July 2005 and will reach the level of the topmost of the new mound in March 2006, and will be connected to the top-dumping table of the new mound.

2. Top-dumping Table – New Mound
This dumping table receives half of the incoming dump trucks loaded with fresh garbage and is programmed to increase in height another 15 - 20 meters from the existing level of the new mound.

3. Transfer Dumping Table at the top of Old Mound
The old garbage mound is programmed to increase in height (same as the new mound) from its existing level, but still with the side slope of 23° from its base.

4. Collapse Area – Old Mound
The construction of perimeter access road in this area commenced in February 2006 prior to the installation of the leachate drainage system, construction of the stormwater drainage and the leachate pump station. This will also require realignment of the creek in accordance with approved design plans.

5. Scandinavian Area – New Mound
Creek relocation is needed about 10 meters away from the base of the garbage mound prior to the construction of the perimeter access road, the storm water drainage, the leachate drainage system and the reprofiling of the area.

The area is very steep and the slope is directly adjacent to the creek going to the Filinvest area. If the creek will not be relocated, the required construction of the perimeter access road along the toe of the garbage mound will further increase the volume of the excess waste material located above the final design side slope of 23°. The excess waste material has to be *loaded and carted to an alternative location. Relocating the creek is essential to minimize costs and allow correct remediation of the existing buffer.*

6. Filinvest Side (Bgy. Singit) – New Mound

Remediation of the face adjacent to Filinvest is going to be very difficult. These areas are very steep and the toe of the slope is directly adjacent to the local waterway. This means that the excess waste material located above the final design slope has to be loaded and carted to an alternative location. The required installation of a perimeter access road will further increase the waste volume to be carted to another site. The most obvious alternative location is to place the excess waste on top of the new mound. This will result in a further height increase.

Alternatively if the toe of the refuse mound could be moved away from the mound, this would allow the preferred final slope to be mainly achieved by merely replacing waste within this slope area.

The perimeter access road will have to be approximately 8 meters wide plus an allowance for the local drains for stormwater and leachate systems, and a separation between the soil cover material and any drains to prevent collapse of the soil into the drains. Therefore, even if the creek at the base of the disposal facility mound is moved closer to the Filinvest property, there will still be a large separation between the toe of the disposal facility and the property boundary.

Proposed Rehabilitation for the Filinvest Side

- *Relocation of the squatters within the Bgy. Singit area*
- *Removal of the earthen mound at Bgy. Singit to a level roughly equal to the Filinvest internal road*
- *Replacement of the concrete block fence along the current alignment at a lower elevation to suit the proposed soil excavation*

- Development of a treed buffer 3 meters wide adjacent to the new fence. This buffer shall be planted with tall species such as bamboo and perennial trees to provide a visual screen to the existing hill
- Relocation of the creek to the south, the distance depending upon the location of the creek at that particular section to abut the buffer
- Development of the perimeter road and associated local drainage
- Installation of the leachate collection system
- Reprofile the waste to achieve a 1:2.5 slope initially, which then settles over time to approximately 1:3 slope
- Incorporate appropriate benching in this batter
- Install appropriate gas collection system
- Place approximately 600 mm of final soil cover
- Plant the compacted soil with vetiver grass and other shrub species

7. Neck of the Two Mounds

The two garbage mound is programmed to connect to each other eventually. First stage of the plan is to connect the area where it is ready for tipping of garbage. Dumping of garbage in this area will resume right after the 25 families affected near the area will be relocated and the construction of the perimeter access road, stormwater drainage and leachate drainage system are completed.

8. Soil Cover

At the end of each day, the tipping face shall be covered. To make the covering easier, the face shall be fully compacted and as smooth as possible. Unevenly

compacted waste surfaces use extra soil to provide minimum thickness cover. The cover thickness shall be 150 mm and should be spread and compacted with about 3 – 4 passes.

9. Greening Component

Planting of mungo beans and calopogonium seeds at the soil covered old mound is needed, this plants will provide nitrogen that is needed to condition the final soil cover prior to the planting of vetiver grass, a simple grass hedge with deep and tough roots, excellent in stabilizing soil cover to prevent soil erosion. Flowering plants shall be planted at the perimeter of the garbage mounds.

Vetiver grass, according to a phyto-remediation study conducted by the University of the Philippines, has a high soil holding capacity because of its root system and also very effective in absorbing heavy metals from waste leachate.

10. Storm water Drainage System

Proper drainage system is an important factor in the stability of the dumpsite. Rainfall that percolates and penetrates the dumpsite may cause localized erosion and slides. Under the conversion project, the dumpsites integrated drainage system was further improved by separating the leachate collection system from the storm water drain.

The open canals and ditches along the periphery of the dumpsite, which serves as catch basin of surface water run-off from the dumpsite and adjacent areas, were widened and maintained through regular dredging to ensure efficient free flow of water while piled sandbags were used to prevent wash-up of the toe of the dumpsite.

11. Leachate Drainage System

The most effective way to control leachate is a combination of design features and operational practices as follows:

- Continuous compaction of incoming waste and provision of daily cover.
- Grading of working and deposition areas to divert rainwater away from the waste working face.
- Provision of surface interceptor drains to divert surface water around the filling area.
- Progressively developing final grades and shapes to shed surface water off the mound as quickly as possible to reduce infiltration.
- Prevent leachate escape beneath the site by means of a clay liner or compacted natural clay subgrade where required.
- Installing leachate drains at the edge of the controlled dump to promote lecahate drainage to collection points.
- Recycling the collected leachate, pumped from the deleaching wells to the dry waste.

The leachate drainage system is installed around the disposal facility and inspected by the Supervisor regularly.

12. Gas Venting and Recovery

To mitigate the potent effect of the gas and the dangers it pose to the dumpsite and surrounding communities, gas vents were installed to collect methane gas. A gas collection system has been installed at both the old and new mounds. This gas collection system reduces greenhouse gas emissions as well as a source of electric power.

13. Perimeter Fence

Perimeter fence was installed to minimize and/or control entry to the dumpsite.

14. Internal and Perimeter Access Roads

The internal access road approaches the current tipping area by going over previously compacted and soil covered waste. The perimeter road was constructed around the disposal facility. Both the internal and perimeter access roads are 8 meters wide.

15. Composting Facility

The pilot composting facility aims to achieve the following:

- To handle, accept and process pilot volume of biodegradable wastes sourced from selected public markets and selected residuals from the manual recovery by waste pickers/scavengers in the Payatas CDF.
- Showcase the use and application of low cost but appropriate composting technologies using vermiculture and microorganisms. The facility shall also serve as a training

and research venue particularly on urban agriculture and related livelihood programs.

- Serve as source of quality compost and organic fertilizer which can be used by the City for its greening projects.

16. Slope Stabilization

Proper grading of the dumpsite in order to improve the surface runoff and prevent infiltration and leachate generation as well as ponding of water. Dumpsite slopes, which previously ranged from 60 to 70 degrees were reduced through side cutting and terracing to a more stable range of 23-25 degrees.

The re-profiled slopes were also compacted and covered with soil to improve stability and minimize or control erosion as well as migration of gas.

7.5.2.1 Strategies to Extend Capacity of the Existing Disposal Site

Several activities are being conducted to prolong life of disposal facility prior to its final closure.

- Implementation of segregated collection
- Further retrieval of recyclable and biodegradable waste by the waste pickers at the CDF. Biodegradable wastes are composted in the area.
- Tire retrieval of tires

7.5.2.2 Various Phytoremediation Processes

The term phytoremediation describes a range of processes mediated by plants that are useful in treating environmental problems. This process is being employed in the disposal area.

- Phytoextraction - uptake of substances from the environment into the plant biomass.
- Phytostabilization – reducing the mobility of substances in the environment i.e. limiting the leaching of substances like heavy metals to the soil.
- Phytotransformation - chemical modification of environmental substances as a direct result of plant metabolism, often resulting in their inactivation, degradation or immobilization.
- Phytostimulation - enhancement of soil microbial activity for the degradation of contaminants, typically by organisms that associate with the roots. This process is also known as rhizosphere degradation.
- Phytovolatilization – removal of substances from soil or water by releasing into the air as a result of phytotransformation into more volatile substances.
- Rhizofiltration – filtering of liquid through the roots by removing toxic substances and excess nutrients.

7.5.3 New Facilities

7.5.3.1 Conversion to Methane Gas to Power

Spontaneous combustion caused by the methane gas produced from the decomposition of organic wastes pose grave threats to the dumpsite and immediate communities.

The "Biogas Emission Reduction Project" of Quezon City is the latest project issued with a letter of approval by the Department of Environment and Natural Resources (DENR),

the country's Designated National Authority (DNA) for the Clean Development Mechanism (CDM). According to DENR Secretary Angelo Reyes, who is also the DNA Chair, the project has demonstrated its environmental, social and economic benefits through the extraction and conversion of biogas to energy. The Quezon City government is aware of the adverse impacts of biogas, on the health of its people and on the environment as a whole. By effectively utilizing biogas, it will help reduce greenhouse gas emissions, thus addressing global and regional impacts of climate change.

Located in Area 2 of Barangay Payatas in Quezon City, the project involves the extraction, collection, processing and conversion of biogas emissions from its 22-hectare controlled disposal facility. Biogas refers to gas produced by fermentation of organic matter such as sludge, municipal solid waste or biodegradable waste. It is mainly composed of methane and carbon dioxide. It can be used for heating or cooking and can likewise be used for generating electricity.

The Biogas Emission Reduction Project of Quezon City will run for 10 years. During that time, it is expected to reduce an average annual reduction of about 116,339.4 tons of carbon dioxide emission. The project involves two (2) phases. The first phase will be composed of a biogas extraction system, a high-temperature torch for flaring the methane extracted and an electrical engine for on-site power supply. The second phase, on the other hand, will begin on the third year, wherein the project will convert a portion of the methane generated to electricity that will be delivered to surrounding communities in the area. Helping the Quezon City government in the project are the Pangea Green Energy S.r.l. and the Pangea Green Energy Philippines Incorporated, a renewable energy company who invests in biogas projects worldwide.

The CDM is a market-based mechanism provided under the Kyoto Protocol, an international agreement designed to assist developing countries such as the Philippines to implement projects that reduce greenhouse gas emissions. Under the carbon trading scheme, developed countries can either undertake to cut domestic emissions of carbon dioxide and five other greenhouse gases themselves or "buy" the equivalent amount of reduction by financing emissions-reducing projects in developing countries like the Philippines.

7.5.4 Sanitary Landfill (SLF) Design

The City is planning to put-up a sanitary landfill however; the City is still scouting for an area. If this will not push through, the City shall be disposing its residual wastes at government designated sanitary landfills.

7.6 Special Wastes

- *Collection of special waste shall be done on a scheduled date and disposed to designated sanitary landfills after treatment.*

- *Manufacturer's responsibility shall be encouraged to get or buy back broken e-wastes.*

- *Waste markets dealing on e-waste shall be organized.*

7.7 Information, Education and Communication (IEC)

7.7.1 Introduction

The main purpose of this section is to enhance people's awareness, knowledge and understanding and to promote active participation of all stakeholders in the program by adopting the desired waste management practices such as segregation and reduction through reuse, recycling and composting. This is based on the premise that an informed constituency is the key to public acceptance.

Components of this section shall be implemented based on a prioritized target audience. Evaluation of the stakeholders' appreciation on solid waste management will be continuously updated to suit the changing needs and conditions relative to the implementation of the Ecological Solid Waste Management.

IEC efforts will be complemented by putting in place an effective and efficient method of collection, transport storage and disposal.

The strategy for implementation in the IEC will be carried out aspiring to achieve the aim of the City to be a model where all of its barangays are practicing segregation at source and segregated collection

Through the EPWMD, community-based IEC program shall be conducted to ensure that all areas in the barangay are saturated.

7.7.2 Core Messages

Generally the IEC materials that will be developed shall follow the fundamentals of the waste management hierarchy. These are as follows: source reduction and minimization of wastes generated at source; resource recovery, recycling and reuse of wastes at the barangay; efficient collection, proper transfer and transport of wastes by the City and; efficient management of residuals wastes.

An inventory of existing IEC materials on ecological solid waste management shall be conducted to determine which will be appropriately used for the campaign. New IEC materials will be developed based on the said inventory. Various types of IEC materials will be utilized in the conduct of program implementation. Print materials such as fliers, leaflets and posters will be developed as collateral materials for community orientations. Billboards will be established in strategic areas to improve chances of messages being remembered by the target audience. Moving films and negatives such as the information commercials shown and viewed in theaters, cinemas, televisions and other similar areas will also be utilized.

Linkage to other partners such as but not limited to media groups, socio-civic organizations, Pos, NGOs shall be established. To ensure the support of these groups in the IEC campaign, it shall be formalized through a Memorandum of Agreement defining the roles of each agency/organizations involved. Regular feedbacking and assessment will be conducted with the partners.

7.7.3 Approach

The first phase of the campaign will be the conduct of series of meetings, orientation and briefings with identified foundation of champions and connectors. These shall include barangay and SK officials, purok leaders, socio-civic and religious association officers and other organizations with networks. A forum on SWM will be conducted with these stakeholders where they shall be requested to influence their constituents to practice waste segregation and management.

Current SWM initiatives of the academe will be sustained and expanded to include other areas of waste management (i.e. composting and livelihood from recyclable materials).

Specifically, to ensure participation of the general public for integrated solutions for waste management, the City shall implement the following IEC projects:

- *City-wide Slogan Contest on Environmental Concern*
- *Household with best SWM practice (Brgy, level contest)*
- *Barangay with best SWM practice (City-wide contest)*
- *Barangay with the highest percentage household compliance on waste segregation contest (City-wide)*
- *Well organized barangay in the implementation of SWM contest (City-wide)*
- *Cleanest and Greenest Barangay Contest (City-wide)*
- *Poster Making Contest on SWM and environmental concern (City-wide)*
- *Best effigy/mascot contest for Quezon City (e.g. super waste manager, super basurero, Recycling man, composter man, etc.)*
- *Poem Making contest on environment concern (City-wide)*

Advertisements through tri-media will be done in the conduct of the contests.

The following educational programs or public education shall be conducted by the City to encourage the constituents to participate in the integrated solutions for waste management:

- Demonstration of Household Composting Process and other ecological system of waste management in television/radio talk shows, film clips and the like.
- Proposal to include in the curricula in the primary and secondary schools the study for the protection of environment and waste management.
- Movie advertisement on proper household waste management.
- Billboards advertisement on proper waste management to be installed in strategic areas.
- Establishment of Training centers for waste management.
- Conduct series of orientation/seminars on waste management in the barangay.

For the educational program to be successful, the City shall develop different ways to sustain the program in order to encourage, draw and sustain interest among the people. The following strategies shall be provided:

1. For TV, Film clips demonstration on waste management. The City shall allocate annual funds for the payment of airtime in the showing of the demo system. The film clips will show the benefits in practicing ecological waste management system in terms of money, health and cleanliness of the surrounding and love of nature.
2. For the proposal to include in the school curricula. The City thru the Board and EPWMD shall formulate a subject module on waste management. This will be indorsed to the Department of Education for the inclusion of the same as one subject or sub-subject to the primary and secondary school.

3. For movie advertisement on waste management. The movie ads on proper waste management will be shown in all movie houses in the City as intermission to regular movies. The City shall allocate annual funds for the production and showing of the movie advertisement on waste management.
4. For billboard advertisement. The billboards to be installed will be large enough to catch the attention of the general public and to be placed in strategic places.
5. For the establishment of training center. Similar to the National Ecology Center, the City shall establish a training center, which shall provide consulting, information, training and networking services for the implementation of the City's Solid Waste Management Plan. The City shall allocate funds for the establishment of this center which includes the provisions for the salaries of trainers, consultants and other necessary expenditures for the sustenance of the program. As such, the Center shall have the following sustenance program:

   - Facilitate training and education in integrated ecological solid waste management
   - Establish and manage a solid waste management information database
   - Promote the development of a recycling market through the establishment of a City's recycling network that will enhance the opportunity for recycling
   - Provide or facilitate expert assistance in pilot modeling of solid waste management facilities
   - Develop, test and disseminate model waste minimization and reduction auditing procedures for evaluation options

6. For the conduct of orientations/seminars on SWM in the barangay. The City thru the Board and EPWMD shall provide competent Trainers and coordinators to handle orientations/seminars on solid waste management in all

barangays. Materials such as flyers, brochures, and other visual aides will also be provided.

7.8 Market Development

Of the total one hundred forty two (142) barangays spread over four (4) districts of the City only thirty six (36) barangays have established composting and/or recycling activities. These facilities are potential economic enterprises that shall generate revenues and help sustain the operation of the solid waste management program.

However, there are different practices and levels in which recyclables are collected, stored and traded. Prior to the collection of garbage by the haulers, most households store recyclables such as aluminum cans, newspapers/magazines, wine bottles and others, which they sell to the junkshops through the push cart traders. The following are the levels of marketing:

- Street trading. Door to door practice of buying of recyclables from the households done by pushcart traders. Prices of recyclables are cheap in this level.
- Junkshops/buyback centers – junkshop trading usually involves the trading of recyclables between the pushcart traders and the junkshop owners. In this level, the prices of recyclables are higher compared to street trading. Push cart traders earn as much as 80-100% of his revolving capital.
- Junk warehouses – The third level of trading wherein recyclables are bought in huge quantities. Usually the clients here are big junkshop traders.
- Recycling plants – Most recycling plants buy recyclables usually in bulk and on a regular basis from warehouses.

Through the Junkshop Standardization Program the City hopes to consolidate the operations of junkshops to the City's SWM Program that receive most of the recyclable materials recovered by individual households and the barangay.

*With regards to composting, small to medium-scale marketing is only possible in barangays with highly-intricate composting equipment such as in the case of Barangay Phil-AM. Selling price need not fully defray the monetary cost of producing the product, the reason being that composting is a service and that it is a viable option in the treatment and disposal of organic wastes. Because of its **role as a service, composting need not generate revenue but at least reach a breakeven**.*

VIII. IMPLEMENTATION STRATEGY

8.1 Framework

The ten year solid waste management plan covers all sectors and addresses problems especially in the implementation of environmental laws. The thrust of the plan is waste reduction/diversion through recycling and composting activities in the Barangay level. Waste reduction and diversion will be focused on the residential areas because they contribute the bulk of the solid waste generated by the City. The City shall require all barangays or cluster of barangays to set up their own Eco-Centers/MRFs. Waste Management Committees shall also be formed and activated in every barangay. The Committee may form Cooperatives for the program to be self-sustaining. Incentives and awards program shall also be part of the approaches to encourage stakeholders particularly the barangays for the effective implementation of the ESWMA.

8.2 Diversion Projections

To comply with the minimum diversion requirement which is 25% of the total accumulated wastes for the next ten (10) years, the Board and EPWMD will see to it that the MRF targets in pilot barangays and in the City MRF will conform with the targets set in this Plan including it implementation. If these projects will be realized, the actual waste diversion will definitely exceed the 25% minimum diversion requirement.

Using the rate of waste diversion provided in the RA 9003, the following quantity of waste will be diverted within five (5) years through re-use, recycling and composting activities.

Table 15. Diversion Projections

Year	Daily Waste Generation (ton)	Target Diversion	
		%	Volume (ton)
2005	1,651.00	20	330.19
2006	1,716.28	25	429.07
2007	1,784.19	29	517.41
2008	1,854.79	33	612.08
2009	1,928.18	37	713.42
2010	2,004.48	41	821.83
2011	2,083.79	45	937.70
2012	2,166.25	49	1,061.46
2013	2,251.97	53	1,193.54
2014	2,341.08	57	1,334.41

8.3 Monitoring Program

The following monitoring programs shall be implemented to ensure that all the projects and activities are being implemented in accordance with this Plan.

8.3.1 Regular Board Meeting of the City Solid Waste Management Board

The Board shall convene once a month to discuss the implementation and development of the solid waste management plan. The board must see to it that all the projects and activities are implemented as scheduled. A monitoring chart of activities will be devised which will serve as a guide for the implementation of the plan.

8.3.2 Monitoring of the MRF Projects in the Barangay.

All the MRF Projects in pilot barangays will be monitored by the EPWMD at least once a month to ensure that the projects are sustained. A monitoring form will be devised to keep track of the system especially the data of the waste diverted thru recycling and composting activities.

8.3.3 Monitoring of the Waste Segregation Compliance by the Stakeholders

In connection with the IEC programs, surveys will be conducted to all sectors to monitor the compliance of the stakeholders with regards to the segregation and storage of wastes. A survey form will be devised for the purpose. Information and data that will be gathered thru these surveys will serve ass the bases for future planning and operation.

8.3.4 Monitoring of the Collection and Transport of Wastes.

The monitoring of the collection and transport of waste will be in accordance with the existing monitoring activities being undertaken by the City. However, the present system can still be improved to cope with the developments in solid waste management as a whole.

- Work Assignment Ticket (WAT). This ticket contains information to properly monitor the collection, transport and disposal of waste. This ticket involves the barangay officials in the monitoring activities since certification is being made if collection of wastes in their area is properly done or not. This ticket also serves as the basis for the payment of bills to the contracted private haulers.

- Mobile monitors. To ensure the proper collection of waste by the private haulers, area monitors on motorcycles will be deployed to check if the area covered by the collection is clean and garbage -free. Penalties are charged against the Contractors if the area is found to be dirty and/or uncollected of garbage.

In addition to the existing monitoring system in the collection and transport of waste, the Work Assignment Ticket being used will be modified further to monitor the segregated collection system. As such, the barangay officials and the Mobile Monitors shall see to it that segregated collections are being strictly implemented and followed.

8.3.5 Monitoring of the Quantity of Waste Collected.

For an accurate monitoring of the quantity of waste, the City will provide a weigh bridge scale which will be used to weigh the amount of waste collected by each truck before the processing of waste will take place. The system will enable the City to acquire an accurate baseline data on the quantity of waste in a given period. The system will also provide information of the waste generation of each sector or source of the collected waste. The data will be added in the work assignment ticket for easy monitoring.

8.3.6 Monitoring of processed wastes.

The person-in-charge of the processing facility shall be required to submit to the board and to EPWD a regular monitoring report which shall contain the following information:

- Quantity of raw biodegradable waste
- Quantity of compost produced
- Quantity of recyclable materials per classification
- Sales of recyclable materials and compost

- Quantity of residual wastes
- Operational Expenses

8.3.7 Monitoring of the Disposal of Waste and of the Disposal Facility

A weigh bridge will also be provided at the disposal facility to quantify the amount of waste disposed. The person in-charge of the disposal facility shall be required to submit to the Board and to the EPWMD a regular monitoring report which shall contain the following information:

- Quantity of incoming waste to the facility
- Existing conditions of the facility
- Operational expenses
- Basic recording data

8.4 Alternative Analysis

The City will consider other options for the diversion of waste materials from disposal other than the MRF projects. In case the turn-out of the waste diversion in the MRF projects will be low, or in case this project will not materialize, other systems and technologies will be adopted such as:

- Pyrolysis
- Plasma Conversion Technology
- Auto Clave (for health care wastes)
- Sterilization (for health care wastes)
- Hydromex
- Other technologies which could be used to properly processes biodegradable, recyclable and residual wastes which may either be developed by the private

sector or the government through the Department Of Science and Technology (DOST).

Technologies that will be utilized shall be in conformity to the ESWMA.

8.5 Incentive Programs

To encourage widest participation of the community in the implementation of the plans and programs on solid waste management, the City Council passed two (2) ordinances granting incentives to the barangays on December 2002. The said ordinances were already described in detail in the previous chapters.

IX. INSTITUTIONAL ASPECT

9.1 Roles

9.1.1 ESWM Board

The ESWM Board is the policy making body that is being chaired by the Local Chief Executive.

The functions and duties of the Board are as follows:

a. Develop the City Solid Waste Management Plan that shall ensure the long-term management of solid waste, as well as integrate the various solid waste management programs and strategies of the barangays in its area of jurisdiction;
b. Adopt measures to promote and ensure the viability and effective implementation of solid waste management programs in its component baranagys;
c. Monitor the implementation of the City solid Waste Management Plan through its various political subdivisions and in cooperation with the private sector and the NGOs;
d. Adopt specific revenue-generating measure to promote the viability of its Solid Waste Management Plan;
e. Convene regular meetings for purposes of planning and coordinating the implementation of the solid waste management programs of the respective component barangays;
f. Oversee the implementation of the City Solid Waste Management Plan;
g. Review every two (2) years or as the need arises the City Solid Waste Management Plan for purposes of ensuring its sustainability, viability, effectiveness and relevance in

relation to local and international developments in the field of solid waste management;

h. Develop the specific mechanics and guidelines for the implementation of the City Solid Waste Management Plan;

i. Recommend to appropriate local government authorities, specific measures or proposals for franchise or build-operate-transfer agreements with duly recognized institutions, pursuant to RA 6967, to provide either exclusive or non-exclusive authority for the collection, transfer, storage, processing, recycling or disposal of municipal solid waste. The proposals shall take into consideration appropriate government rules and regulations on contracts, franchises and build-operate -transfer agreements;

j. Provide the necessary logistical and operational support to its barangays;

k. Recommend measures and safeguards against pollution and for the preservation of the natural ecosystem; and

l. Coordinate the efforts of its component barangays in the implementation of the City Solid Waste Management Plan.

9.1.2 Quezon City Environmental Protection and Waste Management Department (QC-EPWMD)

As an off-shoot of the devolution of environmental management functions to the local government unit, Task Force Clean & Green under the Office of the Mayor of Quezon City was created by virtue of Memorandum Order No. 2, Series of 1992. This Task Force took over the task of solid waste management functions, among others, for the City. It served for nine (9) years until City Ordinance No. 982, Series of 2000 was passed, creating the Quezon City Environmental Protection and Waste Management Department (QC-EPWMD).

QC-EPWMD is tasked with the following:

1. To develop and directly administer a comprehensive environmental protection program which shall specifically cover solid waste management and pollution control;

2. To maintain and operate a garbage collection and disposal system which conforms to the requirements of existing environmental laws;

3. To enforce all laws, regulations and policies pertaining to environmental management and pollution control;

4. To institute a standard monitoring system in the delivery of garbage collection services in the City;

5. To formulate civic consciousness programs geared towards environmental sanitation, e.g. cleanliness, proper waste disposal and waste recycling for the barangays to be implemented in coordination with other non-governmental organizations;

6. To establish linkages and coordinate with offices of the City Government and other national and local government agencies for the promotion of environmental management programs and projects in the City;

7. To maintain and operate a comprehensive pollution control program to include anti-smoke belching and industrial pollution control;

8. To undertake continuing studies and researches on environmental management with the end in view of introducing modern concepts and technologies that can be adopted by the City in the light of existing conditions and regulations.

9.1.3 Barangay Solid Waste Management Committees

The City shall intensify its efforts to oblige all its 142 barangays to organize its Barangay Solid Waste Management Committee. The said Barangay SWM Committee shall be composed of the barangay captain as chair with the following as members: One (1) kagawad, SK chair, president of Home Owners Association, Public/private school principals or representatives, one (1) parents and teachers association president or representative, one (1) religious organization representative, one (1) business sector representative, one (1) environmental NGO representative, president of market vendors association, and a representative from the junkshop owner's association.

The Barangay Solid Waste Management Committee shall have the following functions and responsibilities:

1. Formulate Solid Waste Management program consistent with the City Solid Waste Management Plan;
2. Segregate and collect biodegradable, compostable, reusable waste;
3. Establish a Materials Recovery Facility;
4. Allocate barangay funds and look for sources of funds;
5. Organize core coordinators;
6. Submit SWM monthly reports

9.1.4 Civil Society/Non-Government/Private Sector Organizations

1. NGO's and other civic organizations are expected to support and participate in SWM activities of the City.
2. Business establishments are expected to comply with existing rules and regulations of the City on solid waste management.

3. *Public and private schools are also expected to abide by the Ecological Solid Waste Management Act of 2000 by the introduction of school-based SWM program and the integration of ecological solid waste management in its curriculum.*

9.1.5 National Agencies

Coordination with the following national agencies shall be strengthened to:

1. *The Department of Environment and Natural Resources (DENR) shall be tapped for technical assistance in the conduct of studies, site evaluation, establishment of MRFs and other related activities;*
2. *The Department of Trade and Industry (DTI) for information on potential markets for recyclables;*
3. *The Department of Agriculture (DA) for assistance in the promotion of compost and fertilizers produced in MRFs;*
4. *The Department of Science and Technology (DOST) for information and technical assistance on recycling and composting technologies and training on waste material processing/livelihood projects;*
5. *Department of Education (DepEd) for the integration of SWM topics in the curriculum of related subjects and the integration of school-based programs.*

9.2 Legal

The City Solid Waste Management Board together with the EPWMD shall impose the penalty provisions specified in the Implementing Rules and Regulations of RA 9003 such as:

- Prohibited Acts
- Fines and Penalties
- Administrative sanctions
- Miscellaneous Provisions

City Ordinances concerning environmental protection and waste management will be amended to conform to the provisions of RA 9003 especially in the imposition of fines and penalties in order to set uniform or standard penalties for such prohibited acts. As such, the following prohibited Acts with corresponding fines and penalties as stipulated in the RA 9003 shall be considered:

Table 16. Prohibited Acts

SPECIFIC VIOLATIONS (under Section 49 of the Act)	FINES	PENALTIES
Paragraph 1. Littering, throwing, dumping of waste matters in public places, such as roads, sidewalks, canals, esteros or parks, and establishment, or causing or permitting the same	Payment in the amounts not less than Three hundred pesos (P300.000) but not more than One thousand pesos (P1,000.00) or	Rendering of community service for not less than one (1) day to not more than fifteen (15) days to an LGU where such prohibited acts are committed or both
Para 2. Undertaking activities or operating, collecting or transporting equipment in violation of sanitation operation and other requirements or permits set forth in or established pursuant to the Act Para 3. The open burning of solid waste	Payment in the amounts not less than Three hundred pesos (P300.000) but not more than One thousand pesos (P1,000.00) or	Imprisonment of not less than one (1) day to not more than fifteen (15) days or both

SPECIFIC VIOLATIONS (under Section 49 of the Act)	FINES	PENALTIES
Para 4. Causing or permitting the collection of non-segregated or unsorted waste Para 5. Squatting in open dumps and landfills Para 6. Open dumping, burying of biodegradable or non-biodegradable materials in flood-prone areas Para 7. Unauthorized removal of recyclable material intended for collection by authorized persons	Payment in the amounts not less than One thousand pesos (P1,000.00) but not more than Three thousand pesos (P3,000.00) or	Imprisonment of not less than fifteen (15) days to not more than six (6) months or both
Para 8. The mixing of source-separated recyclable material with other solid waste in any vehicle, box, container or receptacle used in solid waste collection or disposal Para 9. Establishment or operation of open dumps as enjoined in the Act, or closure of said dumps in violation of Sec. 37 of the Act Para 10. The manufacture, distribution or use of non-environmentally acceptable packaging materials Para 11. Importation of consumer products packaged in non-environmentally acceptable materials	For the first time, shall pay a fine of Five hundred thousand pesos (P500,000.00) plus an amount not less than five percent (5%) but not more than ten percent (10%) of his net annual income during the previous year	The additional penalty of imprisonment of a minimum period of one (1) year, but not to exceed three (3) years at the discretion of the court, shall be imposed for second or subsequent violations of Sec. 48 of the Act, paragraphs (9) and (10)

SPECIFIC VIOLATIONS (under Section 49 of the Act)	FINES	PENALTIES
Para 12. Importation of toxic wastes misrepresented as "recyclable" or "with recyclable content" Para 13. Transport and dumping in bulk of collected domestic, industrial, commercial and institutional wastes in areas other than centers of facilities prescribed under the Act	Payment in the amounts not less than Ten thousand pesos (P10,000.00) but not more than Two hundred thousand pesos (P200,000.00) or	I mprisonment of not less than thirty (30) days but not more than three (3) years, or both
Para 14. Site preparation, construction, expansion or operation of waste management facilities without an Environmental Compliance Certificate required pursuant to Presidential Decree No. 1586 and the Act and not conforming with the Comprehensive Land Use Plan of the LGU Para 15. The construction of any establishment within two hundred (200) meters from open dump or controlled dumps or sanitary landfills Para 16. The construction or operation of landfills or any waste disposal facility on any aquifer, groundwater reservoir or watershed area and/or any portion thereof.	Payment in the amounts not less than One hundred thousand pesos (P100,000.00) but not more than One million pesos (P1,000,000.00) or	Imprisonment of not less than one (1) year but not more than six (6) years, or both

X. SOCIAL AND ENVIRONMENTAL ASPECTS

10.1 Social Aspects

One of the greatest setbacks in the implementation of projects on solid waste management especially in the establishment of MRFs is the acceptability aspect of the project by the general public. This is due to the fact that solid wastes, particularly biodegradable wastes emanates odor while it is being processed. The public's clamor on the health concern is always given importance and priority over the SWM system being implemented.

It is in this light that the project site for the establishment of any solid waste facility should be located in a remote area far from human communities especially for large scale infrastructures like transfer stations and sanitary landfills.

10.1.1 Acceptability of Plan Proposals

Solid waste management projects for the community draw both positive and negative impacts from the residents. This depends on the system to be implemented, the attitudes and characteristics of the people living in the community and the quality of leaders implementing the system.

Several barangays have adopted and practiced ecological solid waste management like segregation, recycling and composting. Some barangays have done it on their own initiative, while others were given technical and financial assistance by the City. Some were successful and some were not. The success and failure depends on the three factors mentioned above.

10.1.2 Waste Pickers

For several years now, Payatas Dumpsite has become the lone disposal facility of Quezon City and haven for scavengers. The number of scavengers in the disposal site has increased tremendously when smokey mountain, a dumpsite located in the western part of Manila was closed and the scavengers in this dumpsite migrated and sought refuge at the payatas disposal facility. This is so because waste picking is their only known trade and source of livelihood. And like Smokey Mountain, Payatas is situated in metro Manila, hence, very accessible to them.

At present, there are more than 2,000 scavengers, fourteen scavenger associations in the said facility, including women and children whose source of livelihood comes from picking and selling recyclable materials out of the waste dumped. Each scavenger group is allowed within 20 – 30 minutes to pick on the dumped wastes for recyclables and other materials with value for them. The associations of scavengers were organized to prevent competition and rivalry among them. Each association is given respective area/s and schedules of waste picking activities. Scavengers who are not members of these authorized associations are not allowed to scavenge at the disposal facility.

To improve the living conditions of the Scavengers at the Disposal site in consonance with the Payatas Dumpsite Development Plan, the City proposes the following programs/projects:

- To organize the scavengers into one association as a cooperative and be registered with the proper authority.
- To hire at least one member of each family of scavengers as worker at the MRF within the disposal facility.
- Low-cost housing projects for the scavengers.
- Granting of soft loans for scavengers to engage in junkshop trading and other similar business activities.

10.2 Environmental Aspects

In the implementation of this ten-year plan, all the necessary measures and requirements to protect the environment shall be taken into consideration especially in the processing and disposal of solid waste. Solid wastes creates pollution and becomes a nuisance to the general public and the environment if not properly managed. Therefore, its effect to the environment and human being has to be controlled and remedied.

In the performance of the solid waste management system, each element from generation to final disposal has to be properly handled. The following requirements and measures in handling solid wastes will be considered:

- *On waste generation – Everyone should practice waste management. The City's IEC plan includes advisory to the public to reduce and avoid waste and to do the following measures as a consumer:*
  - *Avoid over-packaged goods.*
  - *Avoid disposable goods and other throwaways*
  - *Buy food in bulk. Patronize products with refillable contents.*
  - *Compost yard or garden wastes. Do not burn it for smoke only contributes to air pollution.*
  - *Patronize recycled and recyclable goods.*
  - *Patronize community "curbside" recycling programs.*
  - *Eliminate household toxic wastes from the garbage stream.*
  - *Patronize products that are made from renewable, rather than non-renewable resources.*
- *On on-site storage – Waste must be stored properly prior to collection.*

- On Collection and transport - RA 9003 provides for the proper collection of solid wastes and the required equipment for its collection.

- On Processing and recovery - These shall include the establishment of materials recovery facilities and transfer stations.

- On Final Disposal - The disposal site's maintenance plan must consider the following: functional rainwater diversion, gas collection system, leachate treatment, and soil covering.

XI. COST ESTIMATES / FINANCIAL ASPECTS

11.1 Investment cost

Section 10 of the Ecological Solid Waste Management Act of 2000 specifically stipulates that the local government units have the primary responsibility to provide solid waste management services. Local governments must rely on a variety of financial resources to fund the services. A mixture of resources may be used for financing the various components of waste management system such as collection, transfer, resource recovery and residual waste management.

The City's Solid Waste Management Plan includes capital investments for the following solid waste management facilities:

- *Sanitary landfill*
- *Materials Recovery and Compost Facility for the City*

However, the estimated capital cost together with the detailed engineering design and construction of these facilities will not be included in this plan since its systems and operations will be coursed through the private sectors through the most suitable financing scheme. Likewise, investment for collection vehicles, including the collection system will also be privatized.

11.2 Annual Costs

In order to generate sufficient revenues to cover the cost of solid waste service, the government should have a thorough understanding of the actual costs associated with providing the service. Unfortunately, very rarely are the costs fully known.

Reflected hereunder is an annual budget of the Environmental Protection and Waste Management Department.

Table 17. Annual Budget

	2003	2004	2005
Personal Services	P 21,524,487.00	P 1,276,719.00	5,818,614.00
Maintenance and Other Operating Expense	P767,079,212.00	P723,667,726.00	P 821,329,400.00
Capital Outlay	P 18,062,750.00	P 18,062,750.00	P 1,786,328.00
TOTAL	P806,666,449.00	P743,007,195.00	828,934,342.00

Included in the maintenance and operating expenses of the LGU are, but not limited to the following: garbage hauling expenses, rentals of equipment for riverways cleanup and equipments for the operations in the Payatas Controlled Disposal Facility. Also included are the incentive package program for the barangay.

11.3 Funding Options

Four (4) financing capital investment will be explored: reserves, bonds, loans/grants and donations. In each options, the community issues tax-exept debt and guarantees repayment of the debt with credit of either the community or the project's revenues combined with any other guarantee or insurance.,

11.3.1 Reserves

In this particular case, the LGU shall receive and save a portion of current revenues for the sole purpose of financing capital investments. Reserves are known also as renewal funds and usually are used for investments in equipment replacement or to extend the service capacity of existing equipment.

11.3.2 Bonds

Another way to obtain financing for capital investments is to raise funds from private investors through the issuance of bonds. Public ownership of solid waste management system or facility generally results in one of three financing methods:

- General Obligation Bonds. This type of financing utilizes the credit of the community as the credit pledge. Principal and interest payments for general obligation bonds can either be made from tax revenues or from the project's revenues.
- Revenue Bonds. This type of bond is repaid from revenues generated by the project or system. The bonds are secured by legal documents specifying the responsibilities of each participant, as well as the flow of funds. If the bonds for a facility of this type are secured only by the project's revenue, they will command a higher interest rate.
- Lease Revenue Bonds. In this type of financing, public entity or a specially formed non-profit corporation issues tax-exempt revenue bonds to finance a waste management facility. The facility is then leased to the City. Security for the bonds is provided by the lease between the two entities. In situations when projected revenues or a particular project are too limited or the risks are too high, it may be in the government's best interest to provide financial incentives to the private sector to

encourage participation in new business development. When the City government provides financial incentives, it either provides financing directly to the private sector or sacrifices potential tax revenues from the private sector. Tax exempt bonds are one example of a government financial incentive that leads to a potential loss in tax revenues.

11.3.3 Loans/Grants

Ideally, most capital investments should be financed through the use of reserves. Nevertheless, in order to finance major capital investments, municipalities may resort to borrowings from commercial banks, international development banks, and central government banks. In some countries, capital expenditures by local governments are controlled by the central government. Each year, the central government sets a limit on the total capital expenditure that can be made. Projects are submitted to the pertinent agency of the central government for approval. Once approved, the local government can borrow either from a public agency or from the money market.

Several international lending institutions have been involved in financing solid waste management investments in economically developing countries. Some of the most active institutions include The World bank, the Asian Development Bank (ADB), and Japan International Cooperation Agency (JICA). The financings covered replacement and expansion of the solid waste collection fleets, construction of the transfer stations and purchase of transfer trucks, design and construction of sanitary landfills and purchase of landfill equipment, development of composting facilities and others. The majority of the financings of solid waste management projects have been included as part of development bank loans for large urban development projects.

Borrowing for major solid waste management investments may be financed through the project or through general obligation financing. In project financing, the financial viability of the project is compared with the revenues that the project is expected to generate. In general obligation financing, the credit of the local government secures the loan. For both types of financing, if future revenues are in doubt, it may be necessary for the government to secure the loan. Most loans for solid waste investments are project financing.

11.3.4 Donations

Local Government Units (LGUs) often have access to a variety of organizations that can donate funds, human resources, or equipment for environmental protection and solid waste management. The organizations can be either national or international. Some of them are willing to assist in solving a specific problem without any conditions, while others impose rather stringent and sometimes costly conditions. This option is purposely included as one of the last options for financing solid waste services because it has been observed that several ill-advised "donations" in which the donations have been encumbered with conditions such that they eventually become costly investment to the community.

11.4 Cost Evaluation and Comparison

Annual Budget Allocated for the Calendar Year 2005 is P828,934,342.00, broken down as follows:

- ***Personal Services Expenses:*** P 5,818,614.00

Of the total amount allocated under this item, only about 5% was spent because only 28 positions were filled-up. The remaining personnel were hired under Contract of Service.

- ***Maintenance and other operating expenses: P 821,329,400.00***

P 600,000,000.00 was allocated for Garbage Hauling Services. The expenses for garbage hauling was computed at P 50,000,000.00 per month for 12 months for the 5 collection districts (District I, District II-A, District II-B, District III and District IV). The amount was based on the price ceilings under the TOR set by the City Government for bidding purposes. However, the actual expenses in a month's time were lower than the ceiling price due to the imposition of fines and penalties on the Contractors for various shortcomings and deficiencies. The penalties accrue as "savings" for the City and were used for Special Operations.

P 193,200,000.00 was allocated for the improvements that were undertaken at the Payatas Controlled Dump Facility.

P 10,464,000.00 was allocated for the salaries of the 155 Contractual Personnel in the Department.

P 5,050,000.00 was allocated for massive IEC-related programs (signboards, flyers, contest in schools and barangays, conduct of special events, rentals, seminars on SWM and Anti-Pollution, etc.).

P 5,000,000.00 was allocated for the Incentive Package Program given to barangays for the savings accrued through waste diversion.

P 3,850,400.00 was allocated for the annual implementation of the Sagip Batis sa QC Project or the Riverways Management Program.

P 3,565,000.00 for Advertisements on SWM.

P 200,000.00 was allocated for office equipment and repairs and maintenance of motor vehicles.

- **Capital Outlay:** P 1,786,328.00

P 1,386,328.00 was allocated for Other Structures - Massive Information Campaign (house to house IEC - Billboards and Flyers).

P 400,000.00 was allocated for miscellaneous expenses.

An average of P400,000.00 a year is earned from penalties paid by Environment Violators. The revenue earned from violators is low because Violators are given the option to render community service rather than pay the fine.

The City has never collected hauling service fees from residential areas. With the approval of the New Revenue Code, however, fees for the collection of bulky wastes was imposed, thereby, generating a total revenue of Php156,412.50 from February to October 2005.

XII. PLAN IMPLEMENTATION

12.1 Phases and Responsibilities

The implementation of this plan will be divided into three (3) phases, to wit:

- ***Phase 1 (year 1 -Year 3)***
  - *Convene the City SWM Board to be a Working Committee*
  - *Establish barangay based MRFs*
  - *Conversion of Payatas Open Dump into a ControlledDump*
  - *New Disposal site scouting and selection*
  - *Implement financing reserves for SWM projects*
  - *Implement IECs*

  Collection
  - *Modification/adjustment of cell collection areas*
  - *Strict implementation of no segregation no collection scheme*
  - *Strict implementation of dedicated collection*

  Transport and Disposal
  - *Proper documentation of waste volume*
  - *Establishment of composting facility for Q.C.*
  - *Continuous upgrading and modification of the disposal system*

- ***Phase 2 (Year 4 - Year 6)***
  - *Closure and rehabilitation of Payatas Controlled Dump*
  - *Post Closure Plan Implementation*

- ***Phase 3 (Year 7 - Year 10)***
  - *New disposal site determination and acquisition*
  - *Development of a sanitary landfill at the Payatas area*

- *Processing of incentive claims on waste reduction initiatives*
- *Implement alternative disposal for special wastes*

12.2 Milestones

The following are the highlights of the plan's implementation:

- *The Board is the decision making body in the implementation of the City's Solid Waste Management Plan. Hence, they will review and decide its final context.*
- *Specific plans and projects that need the approval of the general public (public hearings).*
- *Financing capital investments for the City's Solid Waste Management Projects.*
- *Massive IECs using tri-media*
- *Start of segregated/dedicated collection*
- *Design and approval of SLF for Quezon City*
- *Construction of SLF for Q.C.*
- *Design and Construction of a large scale MRF for Q.C.*

12.3 Implementation Schedule

In addition to the dates specified in this plan, the board shall meet to discuss other specific dates for the implementation of this plan.

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Appendix C - Waste Characterisation Audit and Density Determination Procedures

Introduction

Understanding the materials constituting a waste load is essential in developing any waste reduction, reuse and recycling programs, as well as identifying any materials that would require special management during transport, treatment or disposal.

There are many ways to determine the quantity of waste being delivered to a landfill ranging from desktop studies to making estimates of volumes entering a landfill. However all such methods are at best semi-quantitative as a mass estimate is required as opposed to a volume. Landfill management decisions are always based upon mass and not volume. A second component of waste audits is therefore determining waste density. This then allows the actual mass of waste being delivered to the site to be determined. Because most municipalities do not have access to a weighbridge, then these waste density measurements are necessary.

Aims

The aims of the audit are twofold:

- To segregate and weigh a representative quantity of the mixed waste stream to determine the percentage of various waste components, with a view to improving waste recovery and recycling.

- To determine average waste density and therefore weight of waste in the haulage trucks by weighing measured volumes of waste from selected truck loads, thereby allowing the actual mass per day entering the disposal site to be determined.

Approach to Waste Characterisation

In reality, because most vehicles carry a mixture of waste from different sources (households, market, street cleaning/sweeping, institutions, restaurants, commercial area, etc), there is no opportunity for undertaking audits of individual waste stream types and then recombining the individual waste characteristics. Even if the various waste streams could be segregated into different trucks, such an approach of auditing individual waste streams would not provide statistically valid overall waste data as there is no quantitative manner for combining the audit results of the individual waste streams. This would only be possible if a weighbridge was available to determine the relative mass contributions of the various waste stream types and they could be completely segregated. Because there is no weighbridge available and complete source segregation is not possible, the attempted aggregation of the individual waste stream data would therefore result in major errors.

Therefore the approach is to ensure that a fully mixed waste sample is characterised instead. Audits will therefore be undertaken on a well-mixed sample of the combined waste stream based on selecting representative waste collection days.

In addition, because weighbridges are unavailable, the need to determine the mass of waste entering the disposal site by other means is essential. Various methods are available for estimating the waste mass being hauled but these are only indicative in reality. Therefore the density of selected waste loads will be determined and applied to the total waste volume hauled to site. This will provide a good indication of the daily waste mass hauled to site, which is critical in determining many aspects of the collection, 3RS, waste treatment and finally disposal phases.

There will be different waste sampling procedures depending upon the size of the City, but the actual waste characterisation audit and density determination process is the same at all Municipalities.

Procedure Overview

An audit will be undertaken at an agreed site on the mixed waste being delivered to the disposal site. The audit will take place over 3 days as follows:

- On Day One, the actual audit site will be agreed and the overall procedures discussed with lead labourers, Municipal staff and advisors. The volume of waste in every truck entering the disposal site is to be measured while in the truck body and recorded. Selected typical trucks will then be diverted and the volume of waste in the truck re-measured accurately in-situ. Then the entire load of waste will be weighed to determine the density of waste. This would be done by repeatedly filling rubbish bins with the dumped waste and weighing the bins until the full load has been weighed. The density can then be determined for these specific loads. Samples of waste will be collected from every waste truck (the method depends on the size of the City as described below) and carried to the agreed waste characterisation location.

- On Day Two, samples of waste will continue to be collected from every waste truck (the method depends on the size of the City as described below) and carried to the agreed waste characterisation location. The waste pile is then to be mixed by local labourers hired for the audit. The volume of every truck load entering the site continues to be measured and recorded. Density determinations to continue by weighing selected full truckloads of waste. Waste characterisation will be done by taking waste from the mixed pile prepared over the two days and characterised by segregating the mixed waste into the 14 components for individual weighing.

- On Day Three, both the density and waste characterisation determinations to continue. The amount of waste to be characterised should total about 3 tons and also about 6 tons of waste to be measured and weighed for density determinations.

On all days, the volume of waste in **every truck** entering the site must be measured when in the truck body and the waste volume and truck details recorded.

Procedure Details – Waste Characterisation

1. Prior to the audit, determine if the waste stream is the same every day or are some areas of the City only serviced on certain days. For example, is market waste collected every day or only on certain days. Similarly confirm the collection timing for any commercial, institutional or industrial areas. These discussions will be held with Municipal representatives prior to the audit commencing.

2. Decide which collection days are the most representative of the overall waste stream. Note for example that if waste from say the market is only collected one day a week, but household waste is collected daily, then the auditing must not be biased by this difference - only 1/7 of the market waste pile should be included in the audit for example.

3. The Advisors will confirm with the City to decide the best days for the waste diversion and audit to occur

4. The Advisors will also confirm with the Municipal representatives how many trucks come to site each day on average based on as long a period of records as possible. This will be used to determine the volume of waste delivered on an average day, and ultimately the mass of waste disposed per day.

5. If it is small City, then the Small City procedure described below will be followed. Mid-size and Large municipalities have different procedures as noted below.

6. In all cases, place the waste diverted for characterisation in a separate area and do not mix with other waste being delivered to site.

7. Keep all animals and scavengers away from the audit waste pile

8. Place a plastic sheet on a flat section of ground at least 6 metres square for the characterisation audit.

9. Ensure that the waste is fully separated during the characterisation audit process. For example, a bag full of kitchen waste which is mainly food scraps must be opened and the waste separated. Food stuck to paper or plastic must be shaken off and the food and paper or plastic recorded separately. This is critical or else the results will show too large a fraction of organic waste.

10. Completely separate and weigh <u>all</u> waste each time in the characterisation audit pile <u>before</u> adding any more waste from the stockpile. No residual waste should be left before adding more waste for auditing.

11. Often there is an amount of small mixed material remaining on the plastic sheet after characterising a pile of waste. The Labourers should be encouraged to continue hand separating the waste components in the residuals pile until it is very difficult to proceed as the pieces are becoming too small to separate.
    Only then place the material in the sieve so the larger material are retained and can then be hand sorted into the usual 14 components.

    The finer material passing through the sieve then needs to be closely examined and proportions allocated to the relevant components, such as 50% “Soil and Dirt”, 30% “Food Waste” and 20% “Garden Waste”. These proportions are then applied to the total mass of the fines passing through the sieve and then the various proportioned weights allocated to the appropriate waste type.

For example if there was 50 kg of fines remaining after sieving, with the proportions as listed in the example in the paragraph above, then 25kg would be allocated to “Soil and Dirt”, 15kg to “Food Waste” and 10kg to “Garden Waste”.

To reiterate, it is critical that as much waste as possible is hand sorted and placed into the relevant waste category pile as the highest priority. Only then can the residuals be sieved with the larger retained particles still hand sorted and the fines passing through the sieve weighed and then proportionally allocated to the observed waste categories. The waste types and relative proportions in the sieved fines will vary every time the sieve is used. A finer sieve than that shown in the photograph is preferred at say 10mm aperture.

12. Notes must be kept of any unusual waste such as the presence of medical waste. Do not audit dangerous waste but just record its presence and approximate quantity

13. Note any hazardous waste such as pesticides, solvents or poisons

14. Record the main components of the Miscellaneous Waste category on the data sheet, such as soiled nappies, coconut fibres, etc

SOLID WASTE CHARACTERISATION AUDIT SHEET.

City/City_________________________ Date____/_____/____ Sheet _____ of _____

Material	Kilograms	Comments
Paper/cardboard		
Glass (bottles, broken glass)		
Plastic bags		
Other Plastic (Drink bottles and containers)		
Aluminium		
Other Metal		
Food waste		
Green/Garden waste (Leaves, branches, grass, etc)		
Building/Demolition Waste (Tiles, concrete, bricks, etc)		
Timber/Lumber		
Soil and dirt		
Hazardous Waste (Describe in comments)		
Leather and Fabric		
Miscellaneous (Describe in comments)		

Procedure Details – Density and Mass Determinations

1. Prior to the audit commencing, determine the average number of trucks coming to site every day based on the best available Municipal records. The number of trips made by each truck each day must be determined if different sized vehicles are used.

2. Measure the volume of waste in-situ in all trucks entering the site on all three days. Make general observations on the waste type. These data will be used to determine the mass of waste delivered each day. (Do not just measure the external truck body dimensions as each waste load may only fill a fraction of the total capacity of the truck body.)

3. Divert selected trucks (which appear to contain waste typical of the overall waste stream being delivered to site) to a second dumping area, when labour resources allow, where the volume of the full load is accurately remeasured while still in the truck.

4. The entire waste load is then dumped onto a plastic sheet and then weighed bin by bin, noting that it does not need to be segregated. It is just the total weight of the load that has to be determined. (This combination of in-situ volume and mass will then allow the in-situ density to be determined for these representative loads.)

Note: *A team of 12 labourers (plus support from TA supervisors) should be able to weigh at least 6 tons of waste for the density determinations and a further 3 tons of waste as part of the waste characterisation audit in a three day period.*

Equipment Required

1. 3 x Plastic sheets, each at least 5 metres square – to put under audit waste piles

2. 6 X 100 litre plastic rubbish bins or similar – for carrying waste to the scale. No lid needed but good handles or grips are necessary.

3. Electronic weighing platform scales – for weighing waste when placed in plastic rubbish bins. Capacity of at least 100 kg

4. Sieve – about 10mm for separating out the smaller particles and dirt

5. Data recording sheets – to keep the results of weighing and note any issues (Included at the end of this guide)

6. Personal Protective Equipment – gloves, masks, eye protectors and rubber boots for labourers.

7. First aid kit – in case of cuts or abrasions

8. Water – for drinking and washing

9. 5 shovels and metal rakes, and some barrows – for mixing waste piles and/or loading waste for auditing. Borrow from City

10. 12 labourers (minimum). A budget of USD15 per labourer per day has been allowed previously to compensate for the hazardous nature of the work, as well as compensation for travel out of town to the dumpsite and purchasing meals in such remote locations.

Small Municipalities (Hauling Less Than 5 Truckloads A Day)

Waste Characterization

All collection trucks deliver waste to an agreed separate part of the site on the agreed day/s.

Waste being unloaded into a separate dumping area which is kept free from scavengers and animals until audit is finished

Waste piles from the loads being mixed together. Plastic buckets filled waste from one pile are mixed with the waste in other piles. Waste from the edges of various piles are collected and dumped onto the top of the pile. Aim is to make the overall waste pile one homogenous mixture of waste from the separate truck loads. (An excavator or end loader can be used instead if available of course)

Once the total waste pile is well mixed, separate out one quarter (Sector slice) of the overall waste pile for auditing. The quarter must extend from the edges of the pile to the middle of the pile and to very base of the waste pile.

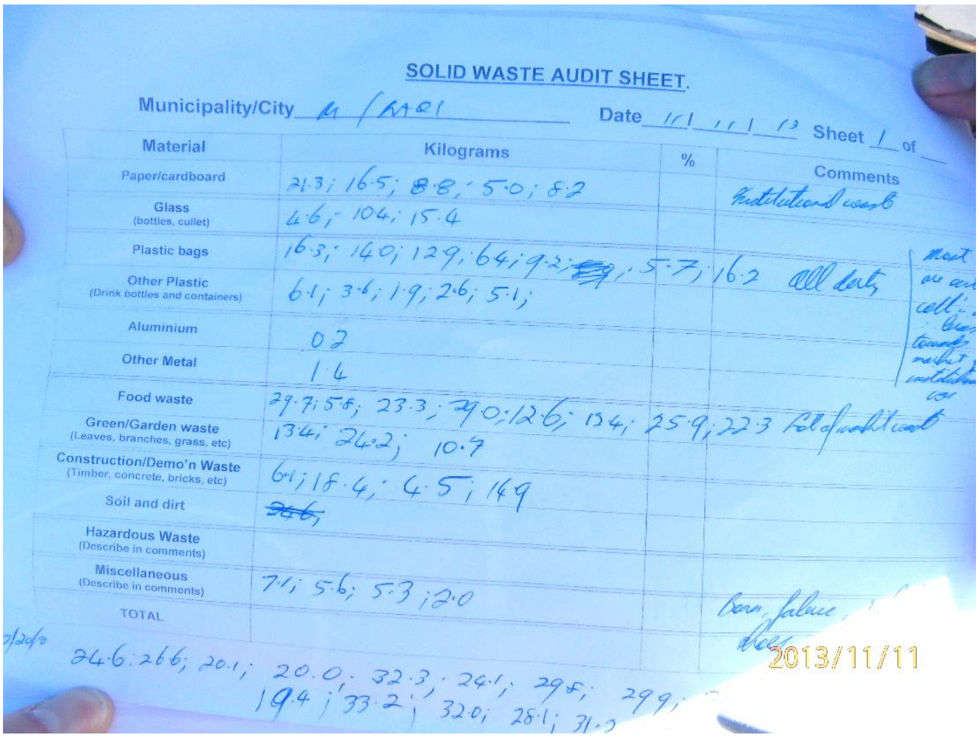
The quartered waste should then be further mixed. Then take waste from the mixed and quartered area (to the right of the pile here) to the audit area as required

Prepare the waste characterization area with signs and plastic sheet

Bring the waste from the preparation area to the audit sheet. Separate the waste into the 14 various components and place near the appropriate sign on the plastic sheet.

Note the plastic sheet under the waste audit pile to prevent contamination and losses. Note use of signs for each waste type. The waste in the audit area must be fully sorted, weighed and removed before any further waste is brought from the quartered pile. Whenever collecting waste from the quartered pile for auditing, take it from a different location with the quartered pile. This reduces sampling bias.

Weigh the various waste components progressively during the audit.


SOLID WASTE AUDIT SHEET

Municipality/City ________ Date 11/11/13 Sheet 1 of ___

Material	Kilograms	%	Comments
Paper/cardboard	21.3; 16.5; 8.8; 5.0; 8.2		Institutional waste
Glass (bottles, cullet)	4.6; 10.4; 15.4		
Plastic bags	16.3; 14.0; 12.9; 6.4; 9.2; [illegible]; 5.7; 16.2		All data
Other Plastic (Drink bottles and containers)	6.1; 3.6; 1.9; 2.6; 5.1;		
Aluminium	0.2		
Other Metal	1.6		
Food waste	29.7; 5.8; 23.3; 29.0; 12.6; 13.4; 25.9; 22.3		
Green/Garden waste (Leaves, branches, grass, etc)	13.4; 26.2; 10.7		
Construction/Demo'n Waste (Timber, concrete, bricks, etc)	6.1; 18.4; 4.5; 14.9		
Soil and dirt	~~24.6~~		
Hazardous Waste (Describe in comments)			
Miscellaneous (Describe in comments)	7.1; 5.6; 5.3; 12.0		
TOTAL			

24.6; 26.6; 20.1; 20.0; 32.3; 24.1; 29.8; 29.9; 19.4; 33.2; 32.0; 28.1; 31.[illegible]

2013/11/11

Continuously record the weights for each waste type and make copies of the record sheet in case it is lost or damaged during the day. Taking photos of the record sheet every hour during the audit is strongly recommended.

Waste Density Determination

Inspect and then measure with a tape measure **all** loads entering the disposal site to determine the total waste volume entering the site each day

Select a typical waste load and have the full load dumped after accurate measurement of waste volume in the truck. The waste will then be weighed (but not sorted) to determine waste density

For these density determinations, waste from a full load (the volume of which has been accurately measured in the truck body prior to dumping in a selected area) is being weighed bin by bin. No waste segregation into components is required as only total overall weight of the full truck load is recorded for this activity. The total weight of the truck load is to be determined and then used to calculate the truck waste density.

Sample results follow below for one load and then all loads combined:

kg	net kg	Volume	kg/m3
1218.5	**963.5**	**5.814**	**166**

	Weight (kg)	Volume (m3)
	963.5	5.814
	1129.5	5.491
	725.9	7.752
	1534.3	8.721
	1300	7.128
	926	6.46
Total	**6579**	**41.366**
Average density	**159**	**kg/m3**

	963.5	5.814
	1129.5	5.491
	725.9	7.752
	1534.3	8.721
	1300	7.128
	926	6.46
	6579	**41.366**
	kg	m3
Average density	**159**	**kg/m3**

Midsize Municipalities (Hauling 5 To 20 Truckloads A Day)

Divert every truck to dump in a designated area but keep each individual pile as separate as possible. No scavenging allowed prior to auditing and keep animals away. The plastic sheets may be used to cover the waste piles until ready for auditing

Select two drums of waste randomly from each individual stockpile for taking to the audit area. Only 1 drum if a small load.

Waste from the individual stockpiles is then carried to the characterization audit area. Once the audit pile is fully sorted, weighed and removed, more waste is carried from the individual stockpiles by again taking drums of waste at random from every stockpile to the audit area. (There should be no residual waste in the actual audit area after every pile is audited, to avoid any sample bias, prior to getting more waste from the stockpiles ready to audit.) The 100L drums must be filled from a different part of the individual waste piles at each filling during the audit.

Note plastic sheet under audit pile to prevent contamination and losses. Note use of signs for waste type.

The actual waste characterisation and density determination processes, as well as measuring every truckloads entering the site, is then the same as for the Small Municipality procedures described above. It is only the waste sampling process that is different.

Still measure the volume of every truck entering the site and select a few trucks for weighing their entire load just for density determination.

The aim should still be 3 tons of waste for full audit characterisation and 6 tons of waste for just weighing (no segregation required) for density determinations.

Large Municipalities (Hauling More Than 20 Truckloads A Day)

1. Collect two (2) plastic bin samples for each 3-5 cubic metres of waste in every truckload entering the site on the agreed day/s
2. Stockpile the waste samples
3. If the resulting sample stockpile is approximately equal to the volume that will be characterised by auditing, then just carry the waste to audit area as required during the actual characterisation.
4. If the sample stockpile is too large to audit, then mix and quarter prior to auditing as described for Small Municipalities.
5. Then just follow the actual characterisation audit and density determination procedures for Small Municipalities

Collecting a waste sample from **every** truck load on the agreed audit days

Must ensure that samples are representative. For example part of the large palm frond was included in the sample

Do the sampling from the trucks near where the audit is to be undertaken, to reduce having to carry the selected waste too far from every truck to the audit area.

Appendix D – Waste Audit Comparisons

Results of International Waste Audits

The Sialkot Solid Waste Management Strategy and Action Plan, Punjab, Pakistan (GHK, 2010) includes data on waste characterisation for three levels of household income as below.

- **Waste Composition of Sialkot, Pakistan**

Waste Type	High Income (Percentage)	Medium Income (Percentage)	Low Income (Percentage)
Paper/cardboard	13	11	12
Food/Organic Waste	40	40	35
Plastic	13	12	12
Glass	5	6	7
Rubber/leather	4	3	2
Metals	2	3	4
Wood	4	4	3
Miscellaneous	19	21	24

The tables below indicate the typical waste components in these countries.

- **Waste Composition of Philippine Cities**

Waste Type	Bamban (Percentage)	Magalang (Percentage)	Mabalacat (Percentage)	Angeles (Percentage)
Paper/cardboard	4.7	6.5	4.4	7.8
Food Waste	9.3	13.7	12.0	18.9
Plastic	16.9	15.3	17.2	17.4
Glass	1.4	2.6	2.4	1.8
Rubber/leather	0.6	1.4	2.0	0.9
Metals	3.1	2.9	1.9	2.1
Textile	0.6	3.2	1.2	3.4
Wood	0.1	1.0	1.9	0.9
Green Waste	54.4	41.7	52.2	40.3
Hazardous Waste	0.0	0.0	0.0	0.0

Miscellaneous	8.9	11.7	4.8	6.6

- **Waste Composition of Vietnam Cities**

Waste Type	Hanoi (Percentage)	Haiphong (Percentage)	Hue (Percentage)	Danang (Percentage)	Bac Ninh (Percentage)
Organics	60.7	57.5	77.1	68.4	56.9
Papers	5.3	5.4	1.9	5.0	3.7
Fabrics	1.7	5.1	2.8	1.5	1.0
Wood	6.6	3.7	0.5	2.7	-
Plastics	8.3	11.8	12.4	11.6	9.6
Rubber& Leather	0.2	1.9	0.2	0.2	0.2
Metals	0.2	0.2	0.4	1.4	-
Glass	5.0	1.3	0.3	0.1	0.5
Ceramics	1.2	0.4	0.7	0.7	-
Soil, sand	5.4	2.9	1.7	6.7	27.8
Ash	2.3	6.0	-	0.00	-
Hazardous	0.8	0.05	-	0.02	0.07
Sludge	1.6	2.7	1.4	1.3	-
Other	0.05	1.1	-	0.03	-
Total	100	100	100	100	100

Appendix E - Source Reduction Policy Options

Source reduction or waste minimisation is a necessary component of a waste management strategy. The benefits of waste minimisation include pollution prevention, reduced need for waste treatment and disposal facilities, and cost savings. The following sections review the major strategies employed to encourage waste minimisation, and are in compliance with the legal framework discussed in the previous chapter.

A primary step in determining the levels of source reduction strategies that can be implemented by generators is to get information on their current waste generation status and disposal practices. The Municipal Solid Waste Management Committee can pass an ordinance that will require high-volume generators, to provide this information for consolidation. This will determine the need for training and/or appropriate technology to promote in order to facilitate source reduction.

The following are examples of policy statements to facilitate source reduction of waste at household level, and are to be incorporated into waste management education and awareness campaigns:

Avoid Non-Recyclables

Policy 1: Any item or product, which cannot be reused or recycled efficiently, must be avoided or not promoted.

A product, which cannot be ecologically processed or disposed of, becomes a burden to the environment and to the local government. As long as the technology or process to appropriately dispose of these products is not accessible or feasible, then the marketing and promotion of such products should be discouraged. Without infringing on the policies of free trade, the City should make it clear to the public that these items, even if they are cheap, are wasting taxpayers' money.

Items like cellophane, composite materials like doy packs and polystyrene can be actually reused or recycled but the technology may not be economically viable at this time.

"One-time-use" products like disposable razors, utensils, plates, cups, toothbrush, wipes, etc. must be avoided, whenever possible, but obviously higher concerns, such as the potential impact on health, must be considered in deciding the use of these items.

Use Re-Useable Products

Policy 2: Products that are packaged for longer use, as in litres, must be given preference over sachets or small packs. Products that are refillable must be given preference over those that are singly packed.

These preferences are related to the impact that these types of packaging have on the ecological manner of their disposal. The practice of packaging in sachets and smaller containers may mean better marketing results, but at greater cost to proper disposal. Using refillable containers may be better if the refills are also packaged in recyclable containers. More often than not, the refills are packed in composite materials, which are in themselves not recyclable.

Various programs can be implemented in order to facilitate source reduction for industries and commercial establishments as well.

The Preventive Principle.

Policy 3: All industries must adopt the “preventive principle” of clean processing and production whereby the majority, if not all, of the components of the production process are recyclable or compostable.

It is cheaper and more effective to prevent environmental damage than to attempt to manage or “cure” it. Prevention requires examining the entire product life cycle, from raw material extraction to ultimate disposal. It encourages the exploration of safer alternatives and the development of cleaner products and technologies.

For example, prevention requires changes in processes and products – designing non-toxic products from materials that can be safely recycled and composted – in order to avoid the generation of waste that needs to be landfilled.

The Democratic Principle

Policy 4: The public must be given access to information and be involved in the deliberations for the approval of industries to be permitted to operate within the City, through the Municipal Solid Waste Management Committee.

Clean production involves all those affected by industrial activities, including workers, consumers, and communities. Access to information and involvement in decision-making, coupled with power and resources, will help to ensure democratic control. Clean production can only be implemented with the full involvement of workers and consumers within the product chain.

The Holistic Principle

Policy 5: Decision on environmental resource use and consumption should not give way to new problems. An holistic approach should be used.

Society must adopt an integrated approach to environmental resource use and consumption. We need to think in terms of systems. For each product we buy, we need to have access to information about the materials, energy, and people involved in making it. Access to this information would help build alliances for sustainable production and consumption. We must also take a holistic approach so that we do not create new problems while addressing old one or shift the risk from one sector to another.

Adoption of Eco-technology

Policy 6: Adoption of “Eco-technology” whenever possible to reduce the use of non-recyclables.

Ecotechnology is the concept of embedding technologies or manufacturing tin the natural cycles of the ecosphere, with its capacity to produce renewable materials. Ecotechnologies are biodegradable and may use a range of biological process in a holistic and non-invasive way, with the aid of efficient engineering.

Shifting Management Costs

Policy 7: The responsibility for disposal of used products should be shared with the producer.

Extended Producer Responsibility can be a way to shift waste management costs from the public sector to the private sector. Today, responsibility for the disposal of used products rests ultimately on local government and the general taxpayer, not on the producer. As solid waste burdens have increased and more stringent disposal regulations have made waste management more expensive, the budgets of local governments have been stretched thin, and local taxes have increased. The sitting of solid waste facilities has become a major issue. Local government have been saddled with the responsibility for a problem that is not of their own making and which they can do little to prevent.

Legislation

Policy 8: Legislate ordinances to apply "Extended Producer Responsibility", like buy back mechanisms and avoidance of packaging waste.

Even since the Ordinance on Avoidance of Packaging Waste was enacted in Germany in 1991, product take-back and related forms of EPR have spread across industrialised countries, industry sectors, product categories, and waste streams. Although some of the applications of EPR may be new, the idea is not. After all, deposit refund systems on refillable glass bottled are some of the earliest forms of EPR.

The range of products and waste streams targeted under these emerging EPR policies includes packaging, paper goods, consumer electronics, office machinery, cars, tires, furniture, electric appliances, buildings and construction materials, mercury, batteries and household hazardous wastes.

In industrialised countries, product take-back programs have been enacted for the following product categories: packaging, batteries (particularly small consumer batteries), electric and electronic products, and end-of-life vehicles.

Appendix F – Waste Minimisation for Special Wastes

Tyres

The minimisation of tyres going for final disposal can be reduced by greater use of retreading, and reuse of tyres, but little else, as they are fundamental requirement in society.

The management of waste tyres has been highlighted as a major environmental problem over the last decades. When disposed of in landfills, tyres tend to 'float' up to the surface of the fill causing significant landfill closure problems. The adoption of shredding internationally as a prerequisite for landfill disposal of tyres has necessitated an increase in tyre disposal costs, creating an alternative market for disposal in tyre dumps. These dumps frequently catch fire, causing significant environmental damage. The creation of tyre dumps usually occurs in response to increased disposal charges at landfills, which have been raised in line with problems of dealing with tyres in landfill systems.

Clearly, there is a need to regulate discarded tyres as a prescribed waste and direct tyre disposal to either recyclable uses or at least require tyre shredding prior to landfill disposal. Those regulations must also prohibit the creation of tyre stockpiles for some undefined opportunity, without at least the provision of significant fire control systems.

A number of re-use and recycling technologies have been developed and implemented or proposed for waste tyres. Almost exclusively though, they require a significant gate charge to cover costs.

Potential recycling applications for tyres include:

- Incineration for energy recovery. A plant is currently being proposed for Perth and two operate in Manila.
- Chip rubber as a compost bulking agent, or use as a permeable layer for leachate or landfill gas collection.
- Sports field improvements (crumb rubber), which improves turf quality and uses about 12 000 tyres per football field.
- Road pavement: rubber modified asphaltic concrete uses about 10 000 tyres per kilometre of 10 m wide pavement.
- Road sub-base: whole and sliced tyre road mat system can be used similarly to geotextile membranes for stabilising poor ground.
- Finely milled rubber can be incorporated into a wide range of rubber or composite products.
- At a lower technology scale, old tyres are converted into sandals in Afghanistan.

- Alternatively they can be given back to households, stacked on edge to form a cylindrical container some 1.3 metres high, and used as an above-ground compost facility.

The discussion above illustrates that a number of solutions can be identified for the waste tyre problem, most of them offering commercial development opportunities. But these will only be viable if;

- tyres become a regulated waste, and (subsequently)
- co-operation between landfill operators and the commercial sector ensures landfills do not become a cheap legal dumping alternative.

Contaminated Soil

In general, landfills can accept any resulting low level contaminated soil if they;

- are clay lined or have an impervious base and walls
- have a leachate collection system and a leachate-monitoring program
- have a groundwater surveillance program.

Low level contaminated soil can generally be used as daily cover, provided that the contaminated soil is not used on any external batters. There is generally no need to mix the contaminated soil with general waste for co-disposal.

Acceptance criteria are available in international publications.

Asbestos

In most countries, asbestos is deemed a prescribed waste. As such it can only be disposed of at landfills according to the relevant national Standard or Act. These landfills should have designated areas marked by grid and depth references. The date and location of disposal is recorded for each load of asbestos.

Therefore there is no real opportunity for reducing the quantity disposed of without incurring a community health risk.

Food Processing Waste

The reduction of food processing waste is usually only successful where there is some financial benefit to the processor, and is therefore very much site specific.

Due to the putrescible nature of the waste, immediately transporting to the Landfill and then covering with other waste will reduce fly and rodent intrusion and odour problems.

Medical Wastes

Biomedical wastes include infectious substances and pharmaceutical substances. The onus is on the waste producer to ensure that wastes are segregated, packaged, labelled, stored, transported and disposed of in accordance with government regulations. Proper segregation of waste at the point of generation (using the internationally recommended colour coding and identification system) will substantially reduce the amount of waste that requires incineration or other approved treatment.

The categories of biomedical waste include;

- infectious substances
- pharmaceutical substances

- laboratory chemical waste

Infectious substances include all waste which is known to be, or could potentially be contaminated with pathogenic micro-organisms (e.g. bacteria, viruses, parasites) and which presents a recognised infectious hazard to personnel handling it, to waste disposal workers and to the environment if appropriate precautions are not used.

Similarly, medications, sharps packages, containers and equipment are often included in their description of pharmaceutical wastes. Cytotoxic chemicals are the most hazardous of pharmaceutical wastes and are substances used in chemotherapy, capable of impairing, injuring or killing cells.

There is no real way to minimise these wastes, apart from careful segregation to reduce cross-contamination of less hazardous waste.

Wood and Agricultural Wastes

Wood wastes, which are too large to shred, should be placed in a designated area prior to pit burning or disposal into the landfill face. This allows scavenging of the stockpiled material in an effort to reduce the quantity to be further treated, burnt or landfilled. Open burning on the landfill should be prohibited as this could cause the landfill to catch fire. Landfill fires can burn continuously for many years causing smoke, heat and explosions.

In the event of a fire in the landfill the affected areas must be excavated and smouldering material saturated with water to ensure the fire has been stopped prior to reburial.

Hazardous Wastes

The study area does not currently have a formal management plan for hazardous wastes. This should be remedied by auditing premises using or generating hazardous waste.

Industrial Waste Minimisation

At present there is no industrial waste in the City. However this may change and the following guideline may then be appropriate.

At the commercial and industrial level of waste production, which typically accounts for some 30% of all waste going to a landfill, the practice of waste minimisation can be assessed on a cost-benefit basis as well as on the basis of an environmental ethic for industry.

Industrial waste minimisation policy has traditionally been targeted at hazardous industrial waste streams. However, the principle can be extended to more than hazardous wastes, including such wastes as poultry processing residues and food processing effluent.

The most important prerequisite for an effective industrial waste minimisation policy is active enforcement of air and water pollution control and hazardous waste management regulations. Even without specific regulations requiring waste minimisation and utilisation of low waste technologies, increased charges for waste disposal and limitations on certain unacceptable disposal practices will provide some incentives for waste minimisation.

Planning controls could be considered for new industry, which make waste minimisation a development consent condition for new industry, or for expansion of existing industries. This would require a waste minimisation audit on the proposed process.

Appendix G – Minimising Plastic Bags and PET Drink Bottles

Plastic bags

Recycling

Plastic bags are only recycled in a few countries where:

- labour costs are very low
- plastic bags are not dirty with organic waste such as food scraps
- there are large quantities of such bags available, and
- where there is recycling facility very close by to overcome the high transport costs for such low density material.

Plastic bags which have not been cleaned can be sold internationally for USD0.07/kg whereas cleaned plastic bags attract a price of USD0.25/kg. Raw polyethylene pellets cost over USD 1.30/kg.

The option of recycling plastic bags, and in particular cleaning soiled bags, must be considered in the whole of life environmental context.

A somewhat similar scheme operates in Manila on laminated plastic and foil juice containers where these are recovered from the landfill and washed prior to being sewn into handbags and other carry bags.

Superficially the scheme is highly successful and has attracted international recycling markets and achieves a very high sale premium. However the washing processing is causing significant local water pollution as obviously the soiled containers are highly contaminated with organics.

So if a similar scheme to wash an ever higher percentage of the total mixed waste stream is proposed locally, then a recirculation system will have to be installed for the plastic bag wash-water with only the bleed off being directed into the leachate management system.

At this stage, recycling plastic bags will first require a waste segregation scheme where clean bags are kept separate from the dirty bags and other contaminants such as food waste. Alternatively the dirty bags need to be scraped and then washed. This will result in significant pollution and makes the whole-of-life considerations for recycling dirty plastic bags unattractive at this stage.

Locally there is very little opportunity for recycling plastic bags apart from burning as a fuel source or bringing in shredding equipment and moulds to make plastic items such as plastic seats. However given that most plastic bags are soiled in terms of either inorganic soil or organic material attachment, the overall environmental cost associated with having to clean and dry these bags, not to mention the higher transport content, would make such a scheme generally unattractive at the present time.

Burning plastic bags

In some countries plastic bags are burnt as a fuel source.

There are many technical papers investigating the health aspects of burning plastics and the general conclusion is that burning any plastic containing Chlorine atoms is dangerous. Burning these plastics, such as PVC (Poly-Vinyl Chloride)) can lead to the formation of carcinogenic compounds such as dioxins.

However almost all thin “grocery” bags are made from High Density Poly Ethylene (HDPE) or Low Density Poly Ethylene (LDPE) which do not produce toxic gases when burnt at normal temperatures. Therefore use of these bags as fuel is a valid recycling/reuse activity provide that the community is educated to only burn bags and not to burn other plastics, which may contain chlorine compounds, such as PVC.

Plastic bag ban

Some cities have taken the step of simply banning the use of plastic bags. An example would be cities with in Metro Manila. This ban applies to both the large supermarket outlets and also smaller corner stores where all purchases have to be placed within paper bags or cartons. This plastics ban has also been extended as far as drinking straws which have to be waxed paper rather than more traditional plastics straws.

This is not been universally supported and there is significant consumer resentment because in the often raining environment with in Manila, the paper bags become wet and grocery items can fall through the weakened wet bags.

This aggressive approach has been taken by the City already.

Plastic bag tax

As mentioned in the chapter above, some countries introduced a charge for the supplying of supermarket plastic bags. In Fiji for example, approximately 2¢ for each shopping bag was previously being charged at supermarkets to discourage people from taking excessive numbers of plastic bags and as a corollary, encouraging people to provide their own reusable fabric bags.

Such a scheme has recently been introduced into the European Union. However to make implementation more streamlined, only those supermarket chains employing more than 250 persons have to charge the tax. Therefore, a similar approach would be just that the larger supermarkets are required to pay the tax as opposed to the markets and the small stores.

Bio/Degradable bags

There a number of degradable plastic bags now available, generally termed:

- Degradable – where the matrix biodegrades leaving numerous small pieces of plastic
- Biodegradable (Oxodegradable) – special additives in the plastic allow the plastic to fully biodegrade over a specified period (Costs 7c to 10cents/bag approximately)
- Compostable – made of organic material such as corn-starch and are not really plastic as such and fully biodegrade (Costs about 21c/bag)

A normal grocery non-degradable bag costs about 3c/bag – range of 2 to 5 cents.

Degradable plastic bags break down primarily through the action of a chemical additive to oxygen, light or heat. The first generation involved just the degradation of the matrix holding the plastic molecules together such that the plastic bag merely broke down into a large number of very small pieces of plastic which then would take many decades to biodegrade. For plastics, degradability refers to change in chemical structure and loss in mechanical properties caused by a specific environment, resulting in the plastic breaking down into small fragments. Such bags are not really environmentally beneficial.

The second generation of biodegradable plastics are also known as 'oxodegradable' bags. These benefit from having chemical additives that can ensure that the entire bag breaks down over a specified time period into the base compounds (Carbon dioxide etc) and not just intermediate resins.

In the first stage, TDPA® accelerates the plastic degradation process by several orders of magnitude, whereby the long polymer molecules are reduced to shorter and shorter lengths and undergo oxidation (oxygen groups attach themselves to the polymer molecules). This process is triggered by heat (elevated temperatures found in landfills or composting), UV light (a component of sunlight) and mechanical stress (e.g. wind or compaction in a landfill). Oxidation causes the molecules to become hydrophilic (water- attracting) and small enough to be ingestible by micro-organisms, setting the stage for biodegradation to begin.

In the second stage, biodegradation occurs in the presence of moisture and micro-organisms typically found in the environment. The plastic material is completely broken down into the residual products of the biodegradation process. As micro-organisms consume the degraded plastic, carbon dioxide, water, and biomass are produced and returned to nature by way of the biocycle.

This time period can be set to vary from weeks up to a number of years as required by the purchaser. In the Pacific Island and many other nations, this has been the preferred approach and the consumer tax for purchasing non-biodegradable bags has been abandoned. The central government in Fiji for example has mandated that all plastic bags must be of the degradable type and this applies not only to shopping bags but also storage bags such as for hot bread, etc.

Compostable plastic bags are often made from farmed products like corn-starch, which, in the right conditions, will break down into elements like carbon dioxide, water and methane. These bags are generally best suited to composting and may contribute to methane emissions if sent to landfill. To meet international standards, bags need to compost within 12 weeks and fully biodegrade within 6 months. These bags are not suited to recycling and are only appropriate for large cities where the bag turnover is very high. However if the bags are stored for protracted periods due to slow sales or distribution issues, the bags will start to biodegrade prior to use. Therefore it is considered that the fully compostable “plastic” bags are inappropriate at this time

Summary

Therefore the recommended approach for plastic bag management is to legislate that all plastic bags have to be biodegradable using the second generation chemistry wherein the bags break down entirely into their prime elements, and not a multitude of small plastic remnants. This approach would also be supplemented through the information and education campaign which would encourage use of reusable fabric bags and the general minimisation the use of plastic bags, even though they would be degradable.

If this is not possible or practical, then a small tax will be applied at the point of sale to encourage people to reuse fabric bags instead of using plastic bags. In parallel, the public could be advised to use the plastic bags as fuel. This has the added benefit of reducing tree felling

Regardless of the option adopted, the community should be educated to minimise the use of plastic bags and encouraged to use reusable (multi-use) fabric bags wherever possible.

PET Bottles

Background

As noted above, these bottles only represent a small percentage of the total waste mass entering the dumpsite. However a large proportion of the bottles are not collected and represent a major component of the local litter concerns, especially given their propensity to be washed into local drain systems and ultimately be washed into the local rivers.

There are a number of options for waste minimisation/source reduction of these containers including taxes, charging policies, container deposit legislation and ultimately, extended producer responsibility.

Charging policies

These are alternatively termed pay as you throw schemes, meaning that any material sent for disposal attracts a specific charge. The idea is that a price signal is then sent to the waste generator to encourage waste Minimisation. However such schemes will only work within an institutional and enforcement environment where illegal dumping or littering is policed.

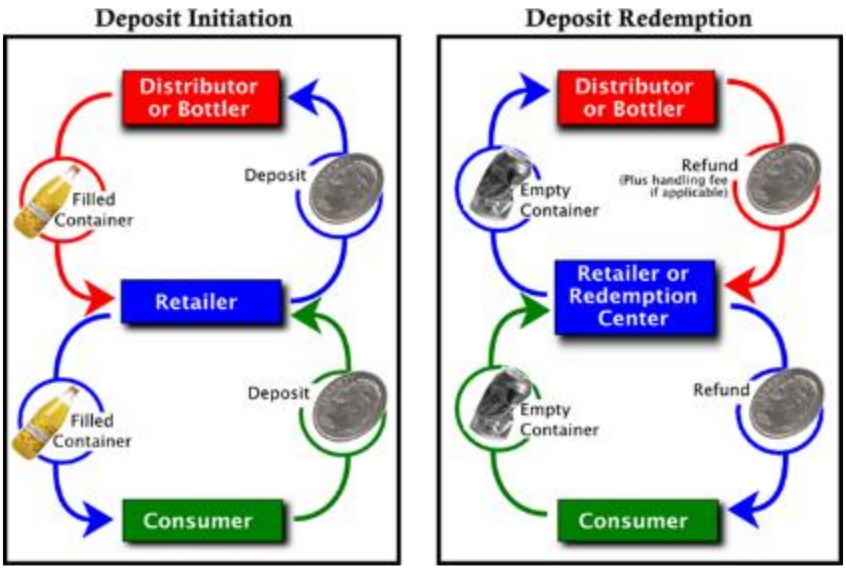
Therefore the basic charging policy should only be applied within a regime of close institutional control but is considered inappropriate at this time.

Container deposit legislation

It was first started in Germany over 35 years ago.

It works when a deposit is charged at the point-of-sale for the container. Traditionally this is mainly been for glass bottles to ensure their recovery and reuse and to a lesser extent aluminium cans. Given the very high recycle rates associated with aluminium globally, there is little merit in applying a container deposit to such a high value recyclable.

When the containers return to the shop, the deposit is then refunded to the person returning the item. This works well in larger shops where there is sufficient storage space to keep the containers awaiting collection by the beverage manufacturer. However for smaller shops, storage space will be at a premium and is particularly the case for small shops that have essentially no spare space for storage.



The other issue is that unless specific legislation is introduced to the contrary, any shop is obliged to refund deposits on an unlimited number of bottles. Some states within the USA have prescribed limits on the number of bottles that can be returned any one time or in fact the hours during which refunds will be paid out. There is no requirement to return the bottles to the same store from which the bottles were purchased for the refund.

The shopkeeper then claims back the deposit from the beverage manufacturer upon collection of the stockpiled containers.

Such a system works in an environment where the beverage manufacturers want the containers returned. However it would be far cheaper for the bottled water manufacturers to simply use new PET bottles rather than having to freight them back from the City to their manufacturing hubs.

To make the return of used PET bottles more financially viable, the bottles would either have to be pressed and baled or shredded prior to exporting. This negates the overall ideal of reusing the original container and morphs more into a recycling program rather than a reuse program which is the usual are aim of container deposit legislation. Furthermore traditionally the container deposit legislation was more focused on durable goods such as glass bottles.

Specialised chippers and granulators are available to reduce the volume required and therefore increase the attraction of recycling plastics, both bottles and bags.

There is always a percentage of unclaimed deposits that are usually retained just as profit by the various beverage companies. In some countries, such as the USA and parts of the European Union, the central government takes an active role in the management of the container deposit funds and actually retains the unclaimed deposits as part of government revenue. This is another level of complexity that is considered inappropriate at present.

There are real concerns with this approach because:

- Small shops will need to provide large secure storage areas.
- The storage areas must be secure as the bottles can be stolen and resubmitted for deposit funds again, or the bottles can be set on fire as they are highly flammable.
- There is no real incentive for the beverage manufacturer to pick up the returned bottles as they would be more expensive to collect, ship and return to their manufacturing bases internationally than simply using new bottles within the international bottling facilities. This is particularly the case with the current slump in oil prices where reprocessed plastic has become far more expensive than virgin plastic leading to the closure a number of very large plastics recycling companies in Europe.
- Therefore there is a real risk of large stockpiles will be generated without any market forces dictating that they would be reused or recycled.

In summary, container deposit legislation for PET bottles may achieve good collection but not necessarily facilitate a sustainable recycling protocol at the current PET prices and export costs.

Extended producer responsibility

This is the next possible step after container deposit legislation which makes the manufacturer of products responsible for the material's entire life cycle. This means the manufacturers are responsible for the take-back, recycling and final reuse for disposal of the products manufactured.

This responsibility is normally applied for larger items and lately particularly for materials such as eWaste internationally.

If extended producer responsibility was applied to these bottles, a very significant cost impact could be expected in the product sale price to the consumer.

Overall it is considered an inappropriate mechanism at this time for PET bottles.

PET tax

Another option is to apply a tax to either the PET bottles or the pellets used for bottle making. A notional charge equivalent to say a few cents a bottle could be applied.

The tax would work in the following manner:

- Government collects the tax on either PET bottles or virgin pellets from the manufacturers;
- The private sector or NGOs could then offer to pay a reasonable amount for used PET bottles for recycling. Such an amount would need to make it attractive for people to collect bottles for sale, especially those from the lower Socio-Economic groups;
- The bottles would then be cleaned, sorted and chipped and perhaps baled to maximize the quantity that could be transported efficiently;
- Once the recycling company has processed the material, the company would present their manifest to the government and receive payment for each ton of PET recycled.

There are approximately 18,000 two (2) litre PET water bottles per tonne making $360 a tonne tax revenue at a notional USD2¢ a bottle. Assuming 75% tax processing efficiency within the government, this translates to approximately $270 a tonne available to support

PET recycling. This would be more than sufficient to make the recycling economically feasible even for remote parts of the Municipality.

Such a tax needs to be considered in terms of whether it is progressive or regressive, and whether it has significant impacts on the less advantaged communities. In fact such a tax would be pro-poor too as usually only about 50% of low to middle income earners buy bottled water. It is generally the middle to upper income bands that purchase bottled water. So the tax would not impact upon the less advantaged communities in terms of access to water.

However the significant increase in recycling would be beneficial to the disadvantaged community groups who would most likely become more involved in bottle collection and sale.

Implementing the scheme will obviously require government support and appropriate legislation.

Overall the purpose of the tax is to make the recycling scheme financially viable for such light material as PET. At the present time, it is only slightly better than marginal. Payment of the collected tax money back to the recyclers would greatly encourage both collection and recycling of this material, leading to a significant reduction in the amount of PET litter and general material waste at present.

Also if haulage costs still remain a constraint, the City could consider providing a small chipper to reduce the volume of the plastic and make transport more economical.

This tax will require the drafting and approval of National legislation.

Appendix H – Larger Scale Composting

Neighbourhood Schemes

The Social Action Centre of Tarlac (SACOT) operates a composting scheme in Dapdap, Philippines.

The scheme uses a hammermill and four motorised compost drums from Happy Soil. Raw product is essentially dry cow manure, mixed with additives such as odour suppressants, Happy Soil enzymes, coco-dust, burnt rice hulls and a small amount of composted municipal solid waste to act as a drying agent in the mix. Each drum is operated for 5 to 7 days, and produces 300 to 500 kg of compost or 12 to 15 bags.

The compost is sold for P150 (US$4) /sack to farmers operating organically-grown rice fields, endorsed and sponsored by SACOT.

The facility tried composting municipal solid waste previously, but the fertiliser content (NPK) was too low for rice agriculture, without needing artificial fertiliser supplements. This caused the permanent changeover to cow manure as the primary input, which provides compost with higher NPK content that is more suitable as a fertiliser replacement than composted solid waste.

The NGO may be suitable as a vehicle for energising the public in terms of solid waste management issues generally. However, the NGO is more focused on assisting farmers with their natural farming methods, rather than solid waste management.

Other issues to be addressed include;

- Vector control: There are existing non-pesticide fly catchers that can be used (i.e. trap-a-fly technology, where flies are attracted by natural means to a trap)
- Odour Control: There are many local deodorisers available that can be utilised by the facility. However, deodorisers are not necessary if the carbon-nitrogen ratio in the compost is maintained, such that no methane is produced beyond tolerable levels. Regular turning and aeration of compost heaps will reduce foul odour. (The composting process will definitely emit a specific earthy odour.)
- Dust control: When compost facility is set-up in windy area, a way of enclosing the area, such as roofing and boundaries, is necessary to control litter and dust.

Another operating compost scheme near the old Smoky Mountain dumpsite has a 1000kg/day capacity, and treats only hand-selected kitchen waste. It is mixed with equal parts of sawdust, plus some thermophilic aerobic bacteria. These bacteria are added every 2 weeks or so and cost P10/kg. The bacteria are added to equal about 10% of the daily throughput of compost. The compost is sold for P3/kg, about 5 cents a kilogram. Because it is partially funded by University research funds, and the equipment costs are not being annualised, the economics of the system cannot be determined.

It had not operated for many weeks prior to inspection.

The Sun Valley composting system has been developed over a number of years to the present system of basic composting. The previous use of mechanised equipment especially motorised composters has now declined because of the costs involved. The present scheme theoretically operates as follows;

- Waste segregation is mandatory into wet and dry waste.
- Wet waste is collected daily by eco-aides from the households. It is mixed with coco dust in the field to assist in drying the waste.
- The impoverished areas do not enjoy a door-to-door collection service for wet waste, because they cannot afford to pay for this. These households deposit their waste into a centralised bin that contains coco dust to limit wetness and the associated odour. The central bins are then collected weekly.
- The bio-waste is then mixed in an old concrete mixer, and blended with chipped greenwaste to provide the carbon rich material and drier material to provide the correct carbon to nitrogen ratio and the optimum moisture content.
- The waste is then placed in open weave bags for 2 to 3 weeks.
- It is then sieved and milled, and re-bagged for another 1 to 2 weeks for maturation prior to marketing.

The compost is not selling that well, apart from some small scale purchases by locals and some visitors. The application of this compost on purpose-built vegetable gardens has also reduced recently. In essence, it is not operating.

Centralised Schemes

Battambang, Cambodia. This small plant accepts only selected wet market waste which is hand sorted twice prior to composting. It is no longer hammer-milled prior to composting because of glass injuries. Hammer-mill not used as injuries from glass shattering kept occurring, even after 2 lots of hand sorting on selected market waste. This confirms the great difficulty in keeping compost feed pure, even when starting with selected and having two lots of hand sorting. The facility only survives because of ongoing equipment updates and daily operating funds provided by a local NGO. It is far from self-funding.

Baguio in the Philippines only runs their plant intermittently and has some old compost on display for demonstration but no new compost is being produced regularly.

Another example of the centralised composting scheme in San Fernando, Northern Luzon, Philippines. It reportedly sells compost at about P3 per kilogram, to the value of P12,000 per month, with production costs estimated at P34,000. The production costs include all labour costs. The scheme is located near to lahar affected areas which would be a prime candidate for using compost on lahar affected soil. Sales are questionable as during three separate visits to the site, the plant was never working and there were no piles of partially aged compost to see, only some very aged product which seemed very dry and possible many month sold.

Aceh, Indonesia has a central plant wh9ich reportedly keeps blocking with coconut husks. It appears to only run very intermittently, mainly for demonstrations. One operator confirmed that the plant is only run intermittently when visitors arrive. Compost is just used for planting a few demonstration seedlings as there is no market for selling outside.

Figure 7 Application of unutilized compost as regular cover in Gampong Jawa Landfill, Banda Aceh, Indonesia.

The large Ha Tinh facility in Viet Nam is designed for 200t/d and is highly mechanised with bag breakers, elevating belts, primary trommel, hammer mill, aerator, secondary trommel, motorised screens and then finally bagging. It has never operated sustainably and also is just started for demonstration. Note the impurities in compost after trommels.

Photo shows the second trommel and screening system after composting

The Lahore compost scheme is 1,000 t/d scheme and is as a result of a PPP with a local farmer who takes all the compost.

Compost quality is potentially poor and unsafe (glass, sharps) at times

Private component is a local farmer who accepts poor compost quality and unconcerned about worker safety issues

Risks

One issue to be considered is the risk management required. For example, Municipalities have been sued for damages due to poor compost causing crop damage due to excessive microbial activity, or personal injury from sharps accidentally included in the compost product in some countries. Even if the compost is given away, there is an inferred warranty that the material is fit for purpose.

Waste must be fully segregated at source to make this option sustainable as centralised waste segregation of mixed waste is unreliable and costly. This means that centralised schemes are possible only for long term consideration locally, not for immediate introduction.

The main risk is not having a sustainable market for the compost, especially where the net costs for the compost operation exceed returns which is usually the case.

If there was a larger fraction of greenwaste that could be separated out at source, then that may be viable to compost as it is many other countries, provided that there is a sustainable market and that there is a supplementary source of Nitrogen such as dried sewage sludge (biosolids) from a sewage treatment plant.

Appendix I - Background to Waste Containers, Segregation and Collection Systems

Introduction

The chapters on waste minimisation, reduction and recycling provide an overview of contemporary schemes worldwide. Some are more aligned with developed countries but are presented as an aspirational guide to the long term options.

This is critical so any medium to long term approaches preferred by the Municipalities are not restricted or prevented by the decisions taken for the short term approaches.

Present Waste Receptacles

Door to door collection involves a mix of hard bins and plastic bags, depending on the location and community wealth.

For community based schemes, some people use plastic bags or other flexible containers such as woven bags, and others just throw the waste unpackaged into the formal or informal primary dumping locations or fly dump their waste onto the nearest local vacant land, drain or river.

Relationship between Receptacles and Waste Segregation Approach

To decide what containers are required, waste segregation and collection must be addressed in parallel.

If waste is required to be sustainably segregated, there must be some downstream benefit realised and supported by the community. Segregation takes time and costs money for the householder, as additional bags or bins are required. Many schemes have subsequently failed because the community does not see any benefit in waste segregation, such as a result of witnessing:

- the segregated waste just being remixed in the haulage truck or at the landfill
- no decrease in their waste management charges/taxes although this may be expected as a result of waste being recovered because of their segregation efforts
- no environmental improvement with demonstrably less litter or uncollected waste apparent in the community

A common starting point for waste segregation is having one colour for wet biodegradables (essentially kitchen waste plus any dirt-free greenwaste) and one for all dry matter including all recyclables and other non-biodegradables.

Usually waste is segregated differentiating biodegradable from non-biodegradable waste to allow mechanised sorting of the recyclables centrally. Based on the waste audits, the high value recyclables are already being adequately recovered and could benefit just from some fine tuning. Therefore the amount of high-value recyclables entering the local waste stream for final disposal is minimal, and would not justify a highly mechanised MRF and therefore traditional biodegradable/non-biodegradable segregation.

However the separation of organics to facilitate animal feeding and composting at a communal or central installation supports this segregation option. Therefore this will require the use of two bins and a commitment to undertake composting at one or more of the institutional levels such as a householder, local commune/neighbourhood or a centralised scheme based at the landfill. The schemes could be located on other municipal land or on private land if a local farmer commits to productively using the compost produced.

The only waste streams of significant mass are the dirt/soil and the organics (green waste and food scraps).

Therefore the appropriate segregation option initially may be to adopt a two-bag approach to segregation of the organics (clean greenwaste and putrescibles) from other waste, and include waste segregation training into the IEC. The greenwaste is only small branches, roots plus leaves suitable for direct composting, and does not generally contain branches large enough to warrant chipping and then composting or direct reuse as erosion or dust protection.

Also the local greenwaste can come from sweepings and contain dirt. This percentage of dirt cannot be composted as the dirt will limit oxygen transfer into the compost windrows severely limiting the aerobic composting process. If there is sufficient dirt, then the compost process will become anaerobic which is much slower and odorous. Given that the dirt is often comingled with the greenwaste during the collection (sweeping) process, the greenwaste/dirt mix would require separation either at the household/street sweeper level or centrally. It is extremely unlikely that householders will be willing, on a sustained basis, to screen their greenwaste using a mesh sieve to separate the dirt from the organics. However householders with suitable large compounds could, as an alternative, simply bury the greenwaste /dirt mixture or place it around plants.

This allows greenwaste to eventually be chipped and reused at the landfill site and this is likely to be appropriate for many years as the City has extensive parklands and gardens and residents have house compounds with extensive greenery.

The ultimate ISWM approach must consider what the waste stream will look like after household wealth increases over time. Ultimately with additional parks and gardens there will be significant quantities of greenwaste that will not be used for fuel. This greenwaste and construction and demolition waste could be separately chipped/crushed and reused as landfill access road cover in wet weather, erosion protection on external mound batters. Alternatively the greenwaste can be used as a compost feed if some future composting scheme is adopted, such as with animal manure or biological sludges from treatment plants.

Waste Containers

Waste containers need to be selected to satisfy segregation needs as well as sensibly integrate with the proposed collection system, either community bins or door to door based.

If waste is to be segregated, there must be some downstream benefit realised and recognised by the community. Segregation usually involves having one container for wet biodegradables (essentially kitchen waste) and one for dry matter including all non-biodegradables. Usually waste is segregated differentiating biodegradable from non-biodegradable waste to allow mechanised sorting of the recyclables centrally. No mechanised sorting such as a Materials Recovery Facility (MRF) is being proposed at this time.

Developed countries have up to 5 separate containers, but three is more common for recyclables, green waste and residuals (both organic and inorganic).

Depending upon any move towards composting, the more traditional waste segregation of organics and non-putrescibles may be more appropriate.

If it is eventually proposed to segregate organics (food scraps and possibly clean greenwaste) from comingled inorganics, the appropriate approach would be to initially continue with using bags with different colours or coloured ties if being collected door to door or just dump segregated waste in the appropriate bins of a community collection scheme still applied.

One additional perspective for this option to reduce plastic bag content in the final waste is to use reusable woven plastic bags for carrying the waste to the appropriate primary dumping location.

The next step would be to have householders use hard plastic or metal bins so that the waste is deposited at the primary dumping location and the bins reused. This will require consideration of methods to manage vermin and flies such as:

- having informal primary dumping locations phased out to avoid putrescible waste simply being dumped in open areas
- moving towards enclosed bins (not the open sided concrete bins) to limit vermin and animal access
- ultimately having skip or hook-lift bins at all primary dumping locations

The next evolution would be to then eventually require hard bins (plastic or metal) to be collected from the household door to door where practicable. Generally door to door collection is only offered for houses along readily accessible streets. The more difficult to access areas often have a community based collection service using hand carts or barrows to bring the individual householders' waste to a primary dumping location, preferably a skip or hook-lift bin. Door to door collection is usually roughly twice the operating cost of community systems.

Daily house to house collection is resource intensive and therefore expensive, and should not be the initial aim of the Municipalities. If waste is to be segregated for commune-based or centralized composting, then a separate collection run will be required for the organics in a different container.

If considered beneficial and sustainable, waste segregation will be encouraged through the IEC campaign. One possibility being for children to establish resource centres at schools recycling household primary recyclables to aid in school project funding, for the households that presently do not segregate and recycle.

Enforcement

If waste segregation is to be adopted, use of the correct containers needs to be enforced in parallel with an overall anti-littering and illegal dumping campaign. It is common in other countries for the waste collectors not to collect waste unless it is in the prescribed bin. Whilst this seems appropriate, care must be taken to ensure that this does not result in uncontrolled littering as a result of non-collection.

Alternatively the waste which is wrongly binned is still collected and the householder fined.

Adopting either of these options will need to be supported by an anti-littering campaign. Such campaigns in developing countries need to be implemented in parallel with an information and education campaign on the environmental and social impact of uncontrolled littering. There also needs to be a punitive component where a small fine can be issued by City or agency officials for repeated littering offences.

These improvements are best considered as long term issues at this stage of community development.

Collection Fleet Options

The existing fleets are barely adequate to collect waste and dispose of it within the City precinct at the secondary disposal locations.

There will be a general aim in the future, particularly as community wealth increases over time, to increase mechanisation in the collection system by way of garbage compaction trucks and skip or hooklift bins. The options are presented in decreasing order of collection and haulage efficiency and reducing capital cost for system establishment.

Waste Compactor Trucks

Ultimately two sizes of compactor trucks would be required. The larger trucks will be appropriate for the larger roads within the City. The method of operation will involve the driver proceeding slowly down the street with staff walking to each house to collect their rubbish (if door to door collection is eventually adopted) and place it directly in the compaction trough at the rear of the vehicle.

The compactors can also be fitted with arms to lift pushcarts or small skip bins into the rear trough, if those systems are proposed for primary dumping locations in some areas of the City rather than door to door collection.

The compactor truck will continue collection in this manner until the vehicle is full when it will proceed directly to the landfill for emptying.

This means that the compaction vehicles do not need secondary dumping locations as the waste is compacted and it is efficient to haul the waste directly to the landfill. These trucks would be expected to make at least two return trips to the landfill each day.

To navigate the narrower streets and alleyways within the City, a larger number of five cubic metre compacting trucks will be utilised. These vehicles will also continue to navigate the local narrower streets and alleyways until full when they will directly haul the compacted waste to the landfill. These trucks would be expected to make at least two return trips to the landfill each day.

Waste compactor trucks have a number of rams, hoses and hydraulic pumps that require maintenance. In some environments, such maintenance can be lacking and the vehicles can become unserviceable.

However this must be considered in the light of the option of not using compactor vehicles. A compactor truck typically can carry 2 to 3 times the mass of waste compared with an open tipping truck are therefore achieve significant costs and environmental benefits. The basic tipping truck also has the need for an hydraulic pump, ram and hoses but admittedly not as many in a waste compactor vehicle.

Finally there are different options for a waste compactor vehicle that do not utilize a ram system. A rotating trommel design as shown in the adjacent photographs is equipped with a spiral steel plate welded to the external shell. The entire cylinder rotates in a system similar to that of a concrete agitator truck. Therefore the only moving parts are the roller bearings and one motor to drive the cylinder. When the waste has to be emptied from the cylinder, the motor is merely reversed and this spiral plate forces the waste from the vehicle. Such systems are becoming more popular throughout Europe and require far less maintenance than a typical waste compactor vehicles using the traditional ram system.

Skip Bins

Skip bins can also be used for community based collection systems and have the advantage of optional wheels so they can be more easily moved to the truck for emptying rather than Hook-lift bins.

However the main advantage compared with hook lift bins is that the waste is compacted prior to hauling. The main disadvantage is that they must be limited in size to about 4 or 5 cubic metres because of bin weight lifting limits. It is common to have multiple bins in one location if a lot of waste is generated locally.

If there are only a few of the bins in one area, then the large compactor trucks can be fitted with lifting arms to empty the skips into the compactor truck rear, along with general loose waste.

Hooklift Bins

The hooklift bins can vary between a minimum of 5 cubic metres to 30 cubic metres. These can be low side bins equipped with rear entry donors to allow walk-in and drive in access to the bin.

Unless these bins have easy access, experience confirms that people will merely dump the waste by the side rather than either reach over the low side to place waste within the bin or a pushcart or Riksaaf trucks can drive into the bin to empty their load without having to shovel it out.

The large bins up to 30 cubic metres capacity are available and will be effective provided that they are of the "walk in" design where people can access the bin through the opening rear doors. The actual size mix and location of the bins will be determined after a detailed public consultation campaign.

The hook lift trucks are able to cart all these bin sizes.

The hooklift bins will be placed at strategic locations based on the following criteria;

- Bins will be need to be near areas where pushcarts and Riksaafs are used to minimise hauling distances for these small vehicles
- Bins will also be placed near institutions such as schools and commercial precincts, especially markets, where door to door collection is inappropriate
- Preference given to using exiting sites where possible as the local community is familiar with the location

- The final location of the primary dumping areas (hooklift bins) will be determined at the time of detail investigation when the final specification of other haulage equipment is determined and will be based on a series of community consultation meetings and council discussions.
- However the number of bins will be kept to a minimum as the waste in bins is not compacted and therefore represents a less efficient haulage model than garbage compactors or skips bins.
- There will not be any open secondary dumping areas where waste is merely placed on vacant land or into drainage easements.

Tip Trucks

A number of body tipping trucks will always be required for the collection of general litter throughout the City. The trucks can be either 10 wheeler vehicles for larger loads and wider streets or 6 wheeler for narrower streets.

Alternatively additional hooklift trucks and bins could be used for this purpose.

Riksaaf Vehicles or equivalent

There are usually a number of small streets and alleyways that are too narrow and uneven to allow access by even small compactor trucks.

Therefore a number of the Riksaaf three wheel vehicles, or equivalent, capable of carrying 200 kg of waste could be utilised.

These vehicles would collect waste door to door from households and then carry the full load to hooklift bins acting as a limited number of secondary dumping areas.

These will only be used where small compactor trucks cannot reach.

Pushcarts

For the very difficult to access areas, additional pushcarts will be purchased.

The modern pushcarts can have capacities up to 600 litres and are fitted with a tipping mechanism to facilitate easy emptying into the hooklift bins.

Alternatively some larger compactor trucks can be fitted with lifting arms to lift the pushcarts directly into the compactor and so primary dumping location can be avoided for these areas.

There are also versions of pushcarts connected to a bicycle to facilitate quicker turnaround if the collection area is somewhat remote from the primary dumping location.

Determining Vehicle Numbers

In determining the number of new vehicles required in the future, it should be assumed a percentage of the existing haulage fleet in reasonable condition would still be used to haul waste. Obviously over time as the City becomes familiar with utilising the new equipment, the existing system can either be renewed for specific duties or replaced with some other more traditional equipment as listed above.

Three other factors should be used in determining the amount of collection equipment required:

- In some cases the bins (both skip and hook type) and also the compactor trucks will not be full when hauling to the landfill. It has been assumed that on average the loads are only 80 percent of capacity

- With an increased number of mechanised items in the fleet, an allowance must be made for both breakdowns and programmed maintenance. It should be assumed that only 80% to 90% of the mechanical fleet would be available at any one time
- Finally is collection every day or only some days a week. The overall fleet capacity has to be increased if not collecting waste every day of the week.

Need for Transfer Stations

Given that there may eventually be a number of hooklift or skip bins acting as replacements for the old primary dumping locations, another option is to consolidate the number of bins and install a small number of transfer stations instead.

Typically, small to medium transfer stations are direct-discharge stations that provide no intermediate waste storage area. These stations usually have drop-off areas for use by the general public to accompany the principal operating areas dedicated to municipal and private waste collection trucks. Depending on weather, site aesthetics, and environmental concerns, transfer operations of this size may be located either indoors or outdoors.

There are many "rules of thumb" for when a transfer station is more efficient than direct haul. Many suggest that the minimum distance is in the order of 20km each way before a transfer station is required.

More complex small transfer stations are usually attended during hours of operation and may include some simple waste and materials processing facilities. For example, the station might include a recyclable materials separation and processing centre.

Usually, direct-discharge stations have two operating floors. On the lower level, a compactor or open-top container is located. Station users dump wastes into hoppers connected to these containers from the top level, or even directly into large open containers such as 20 cubic metre hook-lift bins or 40 foot long high side tipping trailers.

For longer transfer haul distances, the 40ft tipping articulated trailers are the most efficient and can contain the usual road transport limit of about 20 tonnes net without needing any compaction system. There are two basic types, namely end tipping and side tipping. End tipping can be dangerous at dumpsites where elevated trailers have toppled on their sides because of the unstable ground condition sunder the trailer wheels.

The side tipping option is safer if less common.

The required number and overall station capacity (i.e., the size and size of containers) depends on population density of the area served and the frequency of collection. For ease of loading, a simple retaining wall will allow containers to be at a lower level so that the tops of the containers are at or slightly above ground level in the loading area.

Several different designs for larger transfer operations are common, depending on the transfer distance and vehicle type. Most designs fall into one of the following three categories: (1) direct-discharge no compaction stations, (2) platform/pit non-compaction stations, which are very common and simple, or (3) compaction stations, including the sealed vertical silo systems.

The key factor in determining if a transfer station is required is the haul distance from the collection area to the drop off location. Determining the economic point where a transfer station is less costly than using the collection compactors requires a detailed financial analysis and collection of real travel time data.

Staff Training

OHS training will be essential for collection staff as well as environmental concepts and the need for improved ISWM management approaches and litter avoidance specifically.

Options for primary waste collection process

There are a number of approaches to collection of waste from residences and commercial producers. Together these are described in detail as follows. Presented here are some of the possibilities.

1. Householder separates the organics and fines, composts them at the house, and then places residuals in a small household bin. Door-to-door collection of home bins with manually operated handcart by community worker.
2. Door-to-door collection of home bins with manually operated handcart by community worker.
3. Door-to-door collection of waste piles by community worker.
4. Householder takes waste to community bins as it is produced.
5. Householder places waste in indiscriminate piles, to be collected by community worker.

Separation of wastes for household composting

Since between 30% and 40% of the waste has been measured as organics and fines, it means that composting at the household level has the potential to have beneficial impacts on ISWM management from primary collection to final disposal. Removing roughly 1/3 of the waste reduces that which needs to be handled at all three levels – storage at the house, secondary storage and landfill space. It also means that it is much easier to separate out

- **Single bin for household composting.**

other recyclable materials like metal and plastics. Secondly, it means that an extremely valuable soil amendment can be produced and used at virtually no cost to the household.

Depending upon space available, there may not be enough room to compost on-site. However, a mini enterprise for private company could be developed, that could get paid a small amount to take the waste away, than can sell the final product to farmers.

Excellent guidance for backyard composting is available from numerous internet sites. (See the Compost Chapter later for more details) Un-enclosed compost piles are not recommended in an urban setting since these kinds of piles tend to spread out and become unsightly. Home composters are relatively easy to make. However, there are important considerations, such as flies, animals (rats) and odours. A good home compost system will usually have a restriction so that animals cannot get into it. It is usually recommended that meats are not included in the composter.

Alternatively composting can be done even more simply (but less speedily) in ground. Shallow trenches are dug 300mm deep, half filled with organic waste and then covered with soil. The organics remain in-situ until sufficiently biodegraded. The compost can then be recovered and used around the compound.

Since this option diverts up to an absolute maximum of 30% of the waste produced, the containers at the residences can be smaller, or transport to secondary waste sites can happen less frequently.

Diversion of the organic waste also reduces the odour and vector attraction of waste stored at the household.

Positives	Negatives
• Cheapest whole-system option as up to 1/3 of the waste stream could be diverted. • Results in a soil amendment but does not replace fertilisers for any crops requiring overall nutrient dosing. • Requires smaller household bins, or less frequent transport to secondary collection. • Encourages communities to take responsibility and ownership of environment and keep community clean. • Citizens are free to choose how they live and operate. • Does not require every household/ commercial enterprise to participate.	• Relies heavily on individual responsibilities; therefore if citizens do not participate, there will be less beneficial impact. • Households would be required to purchase or build their own composters or trenches. Used tyres can be supplied to HHs for use as compost bins. • An aggressive community education campaign would be required, however, this could have far-reaching impacts beyond ISWM. • A demonstration program would likely be required.

Door-to-door collection of home bins

This alternative is very similar to the first alternative, with the exception that there is no composting component. Although it is a far simpler option, it is not as sustainable, and requires potentially much more SW handling.

▪ Door-to-door collection of home bins.

In this option, all the household and commercial waste is placed in containers. These containers must be bigger than in the prior option, or emptied more frequently. On a weekly basis, the containers are collected with a manually operated handcart and emptied into a community bin, or taken directly to a truck for transport to the landfill.

Given the highly variable long-term sustainability of compost schemes internationally, bins and haulage systems should be sized on the basis of no household based composting to be conservative.

Positives	Negatives
• Can be conducted by a number of entities, including individual stand-alone operator, community based organization arranged operator, City operated staff, or a combination. • Waste producers (householders) don't have to be physically present to take waste out, bin is left at door for operator to collect. • Community groups can take ownership of local environment to keep it clean. • Requires less community education or reliance upon individual.	• The cost of bins. • Relies on worker being available with equipment to collect waste, requires management and routing designation as well as equipment procurement/ maintenance. • Requires coordination and payment of workers and a system that ensures if a worker is absent, an alternate is available and in place to ensure the system continues without failing. • If collection workers do not conduct primary waste collection for over more than 2 programmed collection cycles, then entire system would likely collapse.

Some typical options for household/commercial bins are presented below.

	Metal Bins (60ltr)	Plastic Bin (60Ltr)	Wheelie Bin (120ltr)
			
Price/unit	US $ 30	US $ 20	US $ 70-100
Positives	• Heavy duty/robust – can withstand heavy handling and heavy/dense waste loads. Repairable if damaged; U.V. resistant • Fabricated locally/cheap	• Cheapest option • Lightweight and therefore easily emptied by collection crews.	• Relatively heavy duty and robust body. • Larger capacity while remaining maneuverable. • Fixed lid
Negatives	• Heavier than plastic therefore can be more difficult for collection worker to empty. • Lid likely to be damaged or lost resulting in open container	• Not U.V. resistant • Not robust (especially given composition and density of waste stream) and easily broken • Un-repairable if damaged • Bought in from abroad • Susceptible to vandalism by burning or theft	• Most effective when collected by vehicle with hydraulic bin lift which are not common in • Heavy when full, awkward to manually empty. • Bought in from abroad • Comparatively expensive. • Susceptible to vandalism by burning or theft

This door to door option has the advantage of allowing the waste collector to charge the household or institution directly for removing their waste, especially if collection is to be privatised.

Door-to-door collection of waste piles by community worker

- **Door-to-door collection of waste piles by community worker.**

Waste can also be removed from small piles outside of houses/ commercial establishments with a manually operated handcart operated by a community crew like Alternative 2.

The obvious primary difference is the lack of a container, and the subsequent potential for indiscriminate dumping.

Secondly open piles are attractive to animals and other vectors, who can spread the waste and break open bags. This greatly reducing the environmental attractiveness of this option, and has associated health issues.

Positives	Negatives
• Can be conducted by a number of entities, including individual stand-alone operator, community based organization arranged operator, City operated staff, or a combination. • Waste producers (householders) don't have to be physically present to take waste out, waste is left in a pile for operator to collect. • Community groups can take ownership of local environment to keep it clean. • Requires less community education or reliance upon individual. • Requires little expense at household level to establish practice (no bins).	• Relies on worker being available with equipment to collect waste, requires management and routing designation as well as equipment procurement/ maintenance. • Requires coordination and payment of workers and a system that ensures if a worker is ill, an alternate is available and in place to ensure the system continues without failing. • If system fails and collection workers don't conduct primary waste collection, then entire system would likely collapse. • Increases the potential for indiscriminate dumping. • Can often be spread by animals • Has environmental and health considerations.

Householder takes waste to community bins

A clean and cost effective option is for the household/ commercial enterprise to carry and place their waste in a secondary collection bin as it is generated on a daily basis. If properly implemented, this would be cost effective and environmentally friendly. Secondly, virtually no coordination is necessary between the household and the collector as the capacity of the community bin provides the temporal buffering required.

The community bin could be a concrete bunker, trailer, hooklift bin or skip bin, or in some cases, a transfer station.

Positives	Negatives
• Cheapest option for the household or commercial enterprise. • Least labor requirements for organized crew, as it relies on individual participation alone to get waste to collection spot. • Encourages communities to take ownership of local environment to keep it clean. • Citizens are free to choose how they live and operate.	• Relies heavily on individual responsibilities and therefore if citizens don't participate and take their own waste to the community bin, it will end up irresponsibly discarded on streets. • Transport to community bins is not easily achieved by households and therefore is not often practiced. • An extensive educational program would be required to institute this to a successful level. • Unorganized and un-managed, it increases the potential for indiscriminate dumping. • May require drop bins to be established at a closer interval.

Waste taken by household to open waste piles

This option is a combination of other options, with potentially the least control. Households and commercial establishments dump their wastes in relatively uncontrolled piles that may or may not be formally designated.

This option is what is happening currently in some locations in the City.

Piles are subject to animal scavenging and scattering of the waste. Although virtually no coordination is necessary between the household and the collector is required, un-containerised waste requires collection crews to hand-collect loose waste from the street, which is a hazardous and time-consuming practice.

Positives	Negatives
• Existing practice in many places. • Allows haphazard scavenging to occur, and access to animals. • Least labor requirements for organized crew, as it relies on individual participation alone to get waste to collection spot. • Encourages communities to take ownership of local environment to keep it clean. • Citizens are free to choose how they live and operate.	• Alternative that most results in waste being irresponsibly discarded on streets. • Requires collection crews to hand collect loose waste from the street, which is a hazardous and time-consuming practice. • An extensive educational program would be required to institute this to a successful level. • Unorganized and un-managed primary waste collection system; most difficult for the citizens to see a benefit. • Subject to animal attack and waste spreading with greater vermin concerns.

Secondary collection, ditch and street cleaning

Community bins

A number of both formal and informal drop sites exist for community-level solid waste collection at present. This confirms that a certain level of flow from primary to secondary to final deposit already takes place and is accepted by the community.

With most of the options, the waste is collected through the primary collection system and temporarily stored at community collection drop points – "trash dams," bins, or skips - prior to being transported in bulk to the waste treatment or disposal site, or possibly a transfer station. The function of this component is solely to provide an interim storage site to make operations more efficient. As such, it is very important that they are:

- capable of holding the entire amount of waste brought to them during a set period (for instance, to be able to hold a week's worth of contributions from primary collection if that is adopted as the collection frequency),
- emptied prior to new cycle of waste being brought to them – that is they are synchronized with primary collection, and
- easily emptied and accessible for transport vehicles.

There are a number of alternatives for drop points (primary dumping locations), including

- not using formal drop points – just allowing uncontrolled open dumping
- un-containerised, open piles in agreed locations
- trash dams (permanent concrete or steel bunkers)
- hook-lift bins matched to the collection truck.
- skip bins matched to the collection truck

The open pile alternative is by far the least desirable; the hook-lift bins or skips are the most efficient and clean, but are by far the most expensive initial cost requiring specialized matched equipment.

Hook lift bin systems do not provide any compaction and even partially full hook-lift bins will sometimes need to be transported. Bins cannot be added to one another to fill one bin (to maximise haulage efficiencies) unless waste is manually shovelled from one to the other.

Skip bins are loaded into a compactor truck where not only is the partially full bin issue then overcome, but the compactor truck can then double or treble the waste density making haulage far more efficient.

Locating any of these containers is an important decision. It is important to consider:

- Containers are located strategically, taking into account where community workers or households have established past drop practices.
- There is adequate space to place one or more containers, and access by the collection vehicle.
- They do not obstruct the entrance of any building, or hinder traffic.
- Neighbours will not vandalise them if the waste become odorous or if feral animals spread the waste

- The walking distance from the edge of the bin catchment is sufficiently short so that residents will take waste to the primary dumping location and not fly dump or litter instead. Anything less than 250 metres is usually considered sufficiently close, but reducing this to a 100 metre maximum walk if possible has been found to reduce illegal dumping to very low levels.

The value of locating at existing informal waste disposal sites is that the community is used to these drop locations, and the change in appearance (when a bin, skip or trash dam is placed) is a noticeable visual improvement. Thus objections from the community should be minimal in that case.

- **Selected alternatives for community trash collection.**

	Open piles	Trash dams/Bunkers	Hook-lift Bins	Skip bins
				
Price/unit	- 0 -	US$400 to $600	US$600 to $1500	US$400 to $1200
Vehicle required	Non-specific	Non-specific	Hook-lift truck matched to bin	Forklift-type compactor truck matched to bin
Positives	• Low cost • Disposal points presumably established by community needs	• Static so residents have defined disposal point • Relatively inexpensive • Requires no special equipment • Fabricated locally	• Bins are easier be to relocated as they are not fixed • In an emergency, small bins can be lifted by crane trucks which are relatively abundant, known by mechanics & operators • Fabricated locally • Can be easily removed, cleaned, repaired and replaced • Bins replaced immediately by empty bin	• Bins are easier to be relocated as they are not fixed • In an emergency, skip bins can be lifted by crane trucks which are relatively abundant, known by mechanics & operators • Fabricated locally • Can be easily removed, cleaned, repaired and replaced • Skip bins recycled immediately and waste is compacted in truck
Negatives	• Alternative that most results in waste being irresponsibly discarded on streets. • Requires collection crews to hand collect loose waste from the street, which is a hazardous and time-consuming practice.	• Difficult and slow to access & awkward to empty • Manual labor required to empty exposing workers to health hazards • Difficult to locate as residents don't like them beside house	• Requires specific hook-lift truck matched to bin • Lifting and unloading can cause damage to containers. • Very low risk of container being stolen • Does not allow compaction in transit to landfill	• Works best with specific fork truck matched to bin • Lifting and unloading can cause damage to containers. • Low risk of container being stolen • Does allow compaction during transit to landfill

Collection points should be located at a distance not exceeding 250 metres from the primary collection points. That suggests the distance between two bins should not exceed 500 metres. The size of the trash dam or number of bins can be determined on the basis of the volume of waste likely to be received from the area concerned. That requires a count of the households (to get a number of people) and number of commercial establishments, and the estimated waste contribution from each. For households, the data above can be used to make estimates. Waste generated form commercial enterprises will have to be estimated from inspection or interviews of the business.

Secondary Collection

Depending upon the particular system and configuration, the number of trucks required can be determined. This also depends upon how long it takes to load the waste and how far it is to a landfill/disposal site. For instance, shovelling out a concrete trash dam or a scattered pile takes much longer than it takes to pick up a skip or bin. But it is also possible that a dump truck can hold more than the amount of waste in two trash dams, whereas it may be that the flatbed associated with a crane can only transport two skips/bins. A typical calculation might be:

Skip-crane combination

- 2 skips/truck @ 2 trips/truck/day = 4 skips/truck/day
- 6 days/week = 24 skips/week/truck
- 4.5 m^3/ skip * 24 = 108 m^3/truck/week (assuming that the skip is full when collected)

Trash dam (or informal dump site)-dump truck combination

- a standard truck has a capacity of 5 m^3
- one truck load per day at 6 days/week = 30 m^3/week/truck

It is entirely possible that a combination of systems is put in place in any one city. Some possibilities are show and described as follows.

- **Secondary collection of piles by tractor/trailer**

Secondary collection of piles by tractor/trailer	
Cost of vehicle = US $25,000	
Positives	Negatives
• Equipment is relatively cheap with good availability. • Has a good short turning radius, so it is fairly easy to access tight spots, such as within communities. • Still has maintenance issues with hydraulics associated with the trailer lifting ram and the front bucket system	• Fairly labor intensive to fill trailer by hand. • Shoveling waste is a hazardous and time-consuming practice. • A tractor is very slow on the way to the landfill. • Consider using a transfer station to overcome the tractor's slow speed

- **Secondary collection of containers by tractor/trailer.**

Secondary collection of containers by tractor/trailer	
Cost of vehicle = US $25,000	
Positives	Negatives
• This system by-passes the need to have secondary collection stations, as the household/commercial bins are emptied directly into the trailer. • Equipment is relatively cheap with good availability. • Has a good short turning radius, so it is fairly easy to access tight spots, such as within communities. • Still has maintenance issues with hydraulics associated with the trailer lifting ram and the front bucket system	• Fairly labor intensive to collect bins from households and businesses, though it may be less expensive than shoveling out trash dams or open piles. • Some bins may be fairly heavy due to the majority being fines (earth and ask) and food waste. • A tractor is relatively slow on the way to the landfill. • Consider using a transfer station to overcome the tractor's slow speed

- **Secondary collection of waste in trash dams by dump truck.**

Secondary collection of waste in trash dams by dump truck	
Cost of vehicle = US $90,000	
Positives	Negatives
• This system is very similar to the first alternative, but uses a truck with potentially much greater haulage capacity than a trailer pulled by tractor. • Dump trucks are moderately priced with good availability and mechanical support. • Is capable of good road speed when going to the landfill. • Can access replacement trucks easily as these vehicles are used for many other haulage purposes	• Fairly labor intensive to clean out trash dams. • Shoveling waste is a hazardous and time-consuming practice. • A large truck has poor turning radius, so may not be able to negotiate some narrow roads, or turns. But can use a variety of truck sizes to suit road widths in the city • Truck has hydraulic systems for tipping requiring maintenance (same as tractor-trailer systems)

The next step is to the ultimate system of compactor trucks.

- **Secondary collection of waste in bins by SW compactor truck.**

Secondary collection of waste in bins by SW truck	
Cost of vehicle = US $180,000	
Positives	Negatives
• This system is a very quick and clean way to collect containerized waste. • Low labor requirements and costs. • Relatively high weekly waste capacity. • Provides compaction • Good road speed to landfill	• The most expensive in terms of capital investment, and not generally available locally. • Requires significant room to turn, and bin must be aligned with truck. Smaller rear lift vehicles are available for narrow street areas • May require advanced training for mechanics.

One of the key factors that requires a concerted effort and buy-in on the part of the community is proper use of waste drop sites. In many instances, a trash dam is not properly used, so the result is not dissimilar to having an un-containerized open trash dump site with similar visual, odour and health concerns. This may require an aggressive education effort.

Changing to waste bins (Hook-lift or skip bins) also require some community engagement to ensure that the waste is placed in the bin by the householder or commercial institution, and not just dumped near the bin.

Appendix J - Difficult Waste

Difficult wastes are those wastes that are always allowed to be tipped at the Controlled Landfill but require special treatment to ensure that the best compaction/disposal is achieved. This class does not include hazardous or dangerous wastes, or Special Wastes.

Tyres

Tyres can be a real problem at Controlled Landfills, they are impossible to compact and provide homes for rats. After several weeks or months, tyres "float" to the top of the Controlled Landfill and pierce through the cover. Tyres should be collected in a special area and shredded before they are tipped. Alternatively, the tyres may be useful in remediating the old Dump, or used as scour protection around the external base of the waste mound to prevent erosion from flood flows.

Alternatively tyres can recycled into sandals which is common in Afghanistan.

Mattresses

Mattresses are also hard to compact and are difficult to break up. When found in loads, they should be pushed to the toe of the face and covered.

Whitegoods

When a fridge, freezer or stove is tipped on the working face, it should be carefully crushed to ensure that it is as small as possible. Preferably, these larger items should be stored in the recycling compound and sold to a metal recycler after degassing.

Car Bodies

Car bodies should be collected for sale to metal recyclers. If car parts or bodies are to be tipped, they must be carefully crushed. Operators must take extra care, as there may be petrol left in the tank which could catch fire. If car bodies are collected, they must not be stacked more than 3 high.

Drums

Drums of any material must not be accepted if they are sealed or if they contain any liquid. If a sealed drum is found on the tipping face it must be removed and the Site Foreman notified. He will arrange for the contents to be tested and disposed safely.

Opened drums or large containers of any sort must be crushed before being covered, but should always be recycled if at all possible.

Whitegoods, cars bodies and drums can trap landfill gas and be an explosion danger unless well compacted. In any case, they should always preferentially be recycled.

Appendix K - Special Wastes

These wastes include material that may be accepted into the Controlled Landfill but require special consideration on a case-by-case basis.

Local legislation and ordinances would cover the management of this collective of wastes, when developed, or the national standards and codes as appropriate. These wastes are allowed into the Controlled Landfill on a case-by-case basis only.

Asbestos

Generally the requirement is for all forms (solid sheet and fibrous) of asbestos to be bagged before disposal. Any building (e.g. house) or site where asbestos (even in a sheet form) is being removed, must be:

- removed by a licensed contractor
- site covered with a tent
- all asbestos bagged
- workmen adequately protected in fully enclosed suits and masks, and
- all waste, clothes and tent placed in a shipping container and buried in a defined trench in an approved landfill.

It is proposed that the following procedures be undertaken for the disposal of such waste;

- solid form (fibro-board) - disposal in designated area and covered immediately with night cover
- fibrous/dust form - must be bagged prior to receival at the landfill, disposal in designated area and covered with night cover.

The date and location (grid and depth references) is recorded for each load.

The area where asbestos is deposited is to be identified with date of deposition, quantity, fibrous or bonded, origin, name of contractor and accurate location. It is safe provided that the material bagged and not allowed to escape from the bags in a dry state. It is always safer to keep the asbestos material wet as an added safety precaution.

The asbestos will be managed under any local new legislation, or suitable international standards, such as the Australian Code of Practice for Asbestos Removal and Management NOHSC 2002.

Dead Animals and Obnoxious Waste

Animals and obnoxious wastes will be tipped in front of the Controlled Landfill face and covered immediately. Obnoxious waste would include rotting food produce or other condemned foodstuffs.

The animals and obnoxious wastes should not be placed on the base/liner of the Controlled Landfill.

Non-toxic Liquid Waste

Disposal of large quantities of any liquid wastes and soluble chemical wastes will not be permitted. This may encourage the generation of excessive leachate.

It is common to allow up to five percent (5%) of the total Controlled Landfill waste stream to be liquid. This is because waste usually has a moisture content of 15% to 30%, and is not saturated until the moisture content reaches more than 70%. Leachate will not flow until the waste reaches saturation.

However, because of the moderately high rainfall conditions experienced in the City, liquid waste should not be accepted in large quantities until the Controlled Landfill mound is well established and factual data is derived on leachate generation rates and waste moisture content. Limiting the liquid waste to a maximum of 5% of the waste volume would be appropriate for low toxicity waste, such as grease trap pump-outs.

Preferably, grease trap wastes should be tankered to a sewage treatment plant and discharged to an unmixed, unheated tank. Grease will rise to the surface and form a crust. Solids, such as peelings and scraps, will settle to the tank bottom. The water fraction, which will be the largest volume of the three components, will be drained to the sewage treatment plant inlet works. When the sludge and grease layers build up to excessive levels, the sludge and grease should be pumped out and taken to the Controlled Landfill for co-disposal with the waste. The grease/sludge mixture will be covered as quickly as possible.

Toxic Liquid Waste

These wastes must be recorded for type, source and quantity at the front end of the Controlled Landfill operation. If there is any doubt about the actual content of the load, it should be emptied into a separate trench for subsequent inspection, and if deemed necessary, chemical testing.

The general approach is to pre-treat toxic waste prior to placing in trenches cut into the clay. The waste will then be covered and entombed in the dedicated trench.

An alternative is to store the waste for eventual export to countries, which can provide higher technology solutions. The disadvantages to accessing this higher treatment standard is cost and violation of the general aim that people who produce the waste should manage it themselves and not export their potential problem. Another issue is that the style of treatment proposed for the Controlled Landfill is essentially what happens to most cities' waste in many developed countries in any case.

The possible waste streams and treatment methods are as follows:

Oily Waste Water

The best option is to recycle the oil from the emulsions and suspension. A recovery plant may be available in the future.

These waste waters generally have a high Biochemical Oxygen Demand, high salinity, a waste oil or oil emulsion fraction and potential contaminants such as radiator anti-rust fluids. These wastes usually come from ship bilges and service stations. Because of the potential toxicity, the volume should be limited to 1% of the waste volume. (This is compared with the general non-toxic liquid waste such as grease trap wastes that can be up to 5% of the waste stream)

For quantities exceeding the 1% limit, the waste should be lagooned for separation purposes. The oil film and bottom sludges should be tested for toxins. If below acceptable limits, the solids can be directed into the Controlled Landfill. If the toxin content is considered excessive, solids should be blended with kiln dust, cement, fly ash or clay mixtures to fix the toxins in a cement matrix, and encapsulate any mobile fractions. The resulting solid blocks should be land filled.

Phenolic and Emulsified/Concentrated Oil Waste

This includes wastewaters contaminated with degreasers and decarbonisers, emulsified oils such as machine and cutting oils and other products from light industry and tanker washouts.

Where possible, the phenolics should be oxidised using potassium permanganate. The treatment and disposal method is then the same as for oily wastes.

Acid/Alkali/Metal Wastes

These wastes are derived from metal plating works, metal finishers and the paint manufacturing industry.

Wastes should be neutralised where possible by blending acidic and alkaline wastes. This may require the construction of holding lagoons for the various waste stream components.

The blended product is then treated as for the oily waste by Controlled Landfilling or chemical fixation using cement products. The disposal method is also the same, involving Controlled Landfilling the solidified waste capsules and evaporating where possible the remaining liquid waste fraction.

If evaporation is unsuccessful, the liquid can be added to the Controlled Landfill mound provided that the 1% rule is observed.

Paint/Pesticide/Solvent (PPS) Wastes

This includes all pesticide, fungicide and herbicide wastes, plus solvents such as halogenated cleaners and Methyl Ethyl Ketone derivatives. Sources would include manufacturing processes for the nominated waste types, laboratories and other heavy industry.

This is generally regarded as the most toxic waste stream and requires fixation with cement material, unless the total load can be restricted to less than 1% of the total waste volume. Because the organics do not fix strongly into the cement matrix (unlike metals, which are strongly fixed and become effectively immobile), the resulting cement capsules should be placed in a dedicated disposal trench as monofill. The trench into clay would then be sealed prior to the entry of any stormwater. At least 600 millimetres of low permeability clay should be underneath and around the trench.

The trenches should be located in clay at least 600mm thick below the base of the trench, and at the head of the Controlled Landfill mound to maximise the distance to the creek and any groundwater. Locating the trenches upslope of the Controlled Landfill also allows the surface and groundwater monitoring programs to assess any leakage from the trenches.

The size of the trenches cannot be determined at this time as there is no reliable data on waste generation volumes. They should be sized to accept up to 6 months production of the component waste streams. This will allow the liquid to isolate from surface scums and bottom sludges, and allow evaporation to occur.

The one exception is the Paint/Pesticide/Solvent (PPS) waste, which should be stored for only one month prior to solidifying.

Pathogenic and Medical Waste

Various local medical facilities, such a hospitals and medical clinics, have inadequate facilities to correctly handle all their special waste. This was confirmed by medical wastes appearing in some of the Dumps in the region.

The best solution is to provide a regional medical waste incinerator at the Controlled Landfill. It would be remote from the public, and ash residual could be safely co-disposed with the waste. The incinerator could also treat some of the liquid wastes, such as PPS that has calorific value, provided that the incinerator and anti-pollution equipment is appropriate for these wastes.

The general requirements for an incinerator are that the temperature should be over 1 200º Celsius and a residence time of 2 seconds.

The only residual concern is that the collection and handling of the medical waste must be dedicated and safe, and mediwaste is not co-mingled with other domestic or commercial waste.

Contaminated Soil

This soil can be derived from contaminated sites or dredge spoil. The soil should be tested to ascertain the health and environmental risk profiles, such as using the ASTM Standard Methods for Toxicity Characteristic Leaching Procedure.

There are three options for managing contaminated soil coming to the site, namely;

- Non-acceptance based on laboratory testing, because it is too contaminated for the standard of Controlled Landfill.
- Acceptable into the site but still too contaminated (or unsuitable for some other reason such as too wet) for use as cover material but suitable for incorporation into the waste mound as waste
- Acceptable into the site for use as daily, but not final, cover material

If the soil is determined as being too hazardous for the environmental capabilities of Controlled Landfill, it must not be allowed onto the site and should be directed to a hazardous waste facility. This would apply to highly contaminated soil from an old pesticide factory for example.

However if the soil is not an occupational or health risk, it may be used as daily cover. It must not be used as final cover.

If unsafe to use as cover for whatever reason such as being too wet, it should be incorporated into the Controlled Landfill as normal waste.

Biological Sludge

This material is recyclable, provided that it has been stockpiled or otherwise treated to control pathogens. It should only be Controlled Landfilled if the material is not recyclable, due to excessive heavy metals or biocides or lack of market demand.

The sludge would not require any special treatment prior to Controlled Landfilling with other waste.

Batteries

Lead-acid batteries are recyclable and should not be allowed into the Controlled Landfill.

If the market fails, then batteries should be drained of the acid prior to placing in the mound. However this is a waste of the lead contained in the plates and should only be used as a last resort.

Dry cell batteries, such as torch batteries, should be accepted without any special precautions being required, unless the quantities become significant. This is unlikely however as there is a trend to using rechargeable rather than disposable lead type.

Appendix L - Privatisation

Overview

The options for privatisation are limited in this case where the operation is just for a single local authority. In cases where a facility is shared between Municipalities in a regional approach, then there is greater scope for private involvement for reasons such as the following;

- The scale of operation is larger, and therefore more attractive for a private company to commit Capex funds and mobilise.
- The regional context means that at least one of the City's cannot be directly involved in the operation of the facility. This can result in some friction between the member Cities. Using a third party, possibly the private sector, to operate the facility gets around this issue.
- A further disincentive to involving the private sector is that the work required is relatively low technology, and therefore has low possible margins. The recycling systems for example will most likely be basic Neighbourhood level systems using lower cost civil society or possibly NGO staff. The collection system is unlikely to be mechanised in the foreseeable future to equipment such as side-lift trucks for Mobile Garbage Bins (MGBs) of say 240-litre capacity. Similarly the disposal facility is only a Controlled Landfill which has only basic operational requirements compared with a Sanitary Landfill.

For these relatively simple operations, the private sector may not be attracted because of the low potential for innovative solutions or management that will make the private sector price cheaper than the cost that the City themselves can operate the facility. Once the Controlled Landfills have to be converted to Sanitary Landfills, or perhaps enlarged to become a regional facility, then there may be more scope to involve the private sector.

However if the City is interested in seeking private sector involvement, it can be sought on non-commitment basis. This means that the City can seek tenders for one or more components of their waste management services and compare the offers with their internal records of costs under City operation. If the City appears to be less expensive for the same level of service, then the City would not be obligated to award the tender. In any case, it is likely that the collection, recycling, composting and Controlled Landfill aspects will be undertaken under different arrangements, contractual or otherwise.

It is also critical to consider the length of contracts for privatisation success. Short contracts of a year or two are insufficient to allow the investor to recover his Capex exposure on equipment or site development if a landfilling operation. Any privatisation contracts requiring extensive capital injection by the operator must be at least 5 years in duration, but preferably a minimum of 10 years, to allow amortisation of the capital cost.

The following sub-sections address the most common options for the various levels of private sector participation in the ISWM requirements of the City. The seven (7) generic options are listed below and discussed. The City should just be aware of the privatisation spectrum available to them, and the various pros and cons associated with the options.

Private Sector Involvement Options

The options are described below.

Service Contracts

These delegate particular operations and maintenance (O&M) functions to a private operator for a short period of time (one or two years) in return for a specified fee. These could be appropriate for operating a Controlled Landfill or collection services if the scale of the operation is sufficient.

Management contracts

These allocate responsibility to a private operator for the full range of O&M decisions, typically for three to five years, or longer. The private operator is paid a fee, which may sometimes be linked to performance. It could be appropriate for operating a small Controlled Landfill if the scale of the operation is sufficient.

Build Operate Transfer (BOT) contracts

BOT contracts give the responsibility to a private operator (or consortium) both to finance and construct an infrastructure facility and to operate and maintain it for a specified period of time. At the end of an agreed period, ownership of the facility is transferred to the government at a symbolic cost.

The private operator retains all the revenue from operating the facility for the period of the contract, to pay for the capital and operating expenditure. This revenue stream typically consists of fees paid by the public sector user and commercial operators.

Such a scheme would only be suitable for a very large landfill or major collection service.

Criteria for Privatisation Method Decision

The decision on whether to consider privatisation of some sort must be based on suitable criteria, such as those listed below for both the public and private sector perspectives.

Public Sector Perspective

Four groups of criteria can be considered when choosing between privatisation options:

Financial criteria.

State owned utilities can place a variety of financial pressures on the public purse, which governments may wish to reduce:

- Subsidies to loss making utilities to finance existing operations
- Funding of substantial new investment to increase capacity and improve service quality.

The greater the public sector deficit, the more important financial considerations are likely to be as a motivating factor towards privatisation. Privatisation options may relieve some of the pressure by:

- Reducing or gradually eliminating subsides and cross-subsidies, through greater efficiencies of private sector operation, and the phasing of tariff increases up to cost recovery levels. Such increases may prove politically easier to implement under private rather than public operations.

- Attracting finance to meet new investment needs, thereby avoiding the need to incur additional public expenditure.
- Generating cash revenues through the private sale or flotation of public assets. The funds can be used to create a reduction in public sector debt or to fund alternative projects.

Efficiency of service criteria.

Public owned utilities may have relatively low levels of efficiency, since there are poor incentives for cost reduction. Introducing private expertise and management methods can improve efficiency in a number of different ways:

- Increasing productive efficiency linked to reductions in operating costs even without substantial new investment.
- Stimulating innovation driven by the adoption of new technologies in the context of an investment program.
- Improving the quality of service, as long as targets are clearly set by the public sector.
- Raising accountability to customers, brought about by the market context.
- Increasing tariff/fee collection efficiency, as a result of the profit motive of the private operator.

Ideological criteria.

Where governments are undertaking a wide range of policies involving deregulation and pro-market reforms, privatisation will be enthusiastically embraced. In this context, it is viewed as a means of increasing private participation in the economy and may be used to encourage wider share ownership. Where governments do not espouse to a free market political philosophy, privatisation may be undertaken more reluctantly primarily as a means of funding new investments or improving the efficiency of public services. In these cases privatisation is likely to be accompanied by special measures to ensure continued public control.

A desire to retain maximum public control may lead governments to adopt contractual forms of privatisation as opposed to asset sales. However, asset sales need not entail a loss of public sector control. The government can retain a controlling stake and use the proceeds of privatisation to achieve wider social goals.

Administrative criteria.

Two aspects of the privatisation process will create a significant administrative burden:

- Preparation. Assembling information on the state of the existing infrastructure assets, assessing the quality of the competing bids, providing reliable revenue and cost forecasts for the operation of the contracted services.
- Regulation. Ongoing costs of regulating the activities of the private operator, on both price and non-price performance parameters.

Private Sector Perspective

Private operators will consider the balance between risk and return when selecting between possible investment opportunities.

Potential risks may include:

- Commercial risk from the operation and maintenance of the service, subject to demand, cost and revenue volatility.
- Project risk from uncertainties in forecasting costs and revenues attached to investment responsibilities.
- Country risk from exchange rate volatility, which may affect profitability for foreign operators.
- Regulatory risk from unexpected alterations in the regulatory conditions, such as political interference.
- Force majeure risk from damage to assets owned by the private operator, as a result of natural disasters.

Potential factors affecting the return on investment include;

- Bidding costs. Preparing the bid and participating in the selection procedure, compared to the probability of winning the contract and the resulting revenue stream.
- Cost reduction potential for efficiency gains, and whether the resulting profits can be retained by the operator.
- Revenue expansion through increasing the size of the market and the associated flow of revenues.

In general for private operators:

- Service and management contracts lie at the low level risk, low reward end of the spectrum.
- Lease contracts and concessions offer a somewhat higher level of risk, but offer the opportunity to increase revenues through demand growth.
- BOT and BOO contracts are high risk, with limited scope for demand growth.
- Private sales and flotations also carry significant risk, but may allow high returns depending on the terms of the regulatory regime.

Service Contracts and Management Contracts

Service and management contracts have the lowest degree of private sector involvement. These options give financial relief to governments, and some scope for efficiency improvements by the private operator.

Circumstances in which governments tend to consider service and management contracts are:

- Modest public sector deficit
- Inefficient public services
- High risk environment for private operator
- Desire to experiment with small scale privatisation
- Ideological ambivalence towards privatisation
- Low availability of regulatory capacity

These conditions generally apply to the current City environment, and as such, Service Contracts and Management Contracts are the most likely options for privatisation locally, from both the public sector and private sector perspective.

Public Sector Perspective:

The key differences between service and management contracts is that management contracts offer somewhat greater scope and incentive for efficiency improvements, and create a slightly greater administrative burden if there is performance based remuneration.

Advantages.

The advantages of service and management contracts are:

- Minimal ideological implications given the limited responsibilities transferred to the private sector.
- Comparative light administrative and regulatory burden.
- Possible efficiency improvements through skilled private management, which may reduce subsidies or lower customer tariffs, see also disadvantages.
- Possible quality of service improvements through performance related bonuses.
- Opportunity for private operators to acquire experience and knowledge of the local infrastructure, necessary to operate a more comprehensive and demanding contract in the future.

Disadvantages

The disadvantages of service and management contracts are:

- Limited scope for service improvements, with little incentive for cost cutting measures because of the short period over which benefits can be retained by the private sector.
- Efficiency gains are likely to be significantly smaller than they might be under a more complete form of privatisation.
- Improvements may not be transferable to the public sector at the end of the contract -especially if the benefits are largely attributable to the management skills of the private operator. These will be entirely lost unless adequate training measures are incorporated into the contractual structure.
- The separation of responsibility for the operational and investment decisions between private contractors and the public body introduces the danger of coordination problems between these two areas of decisions making.

Private Sector Perceptions

For the private operator, the key difference is that management contracts offer greater autonomy, but also additional risk if the contract is structured to include performance based remuneration.

Advantages.

Such contracts are low risk given that:

- The operator's compensation generally takes the form of a fixed fee.
- The relatively short duration of the contract reduces exposure to political risk.
- The operator is not required to make any irreversible financial commitment in the form of large investments.

Disadvantages

The rewards are limited, given the:

- Low degree of managerial autonomy
- Relatively small scope and little incentive for cost cutting
- Limited opportunity for expanding revenues.

BOT and BOO contracts

These contracts are of greatest relevance where governments need to harness private capital to finance rapid expansion in the capacity of infrastructure services. They can be seen as a variant of contracting public works, where the remuneration for the operator is not a lump sum paid up front, but a risk bearing compensation scheme spread over a period of time.

Circumstances in which governments tend to consider BOT and BOO contracts are:

- Public sector deficit
- Major infrastructure needs
- Attractive environment for private investment
- Ideological ambivalence towards privatisation
- Medium availability of regulatory capacity

BOTs and BOOs have been used mainly in power generation, transport infrastructure and water treatment services.

The only real difference between BOT and BOO contracts is the ultimate asset ownership, which may make the BOT option more attractive for governments reluctant to relinquish ownership in the long term. A potential complication with the BOT contract is the loss of incentives for asset maintenance as the transfer date approaches, so additional regulatory effort may be required towards the end of the contract period.

Public Sector Perspective:

Advantages.

The principal advantages of these privatisation options are;

- They enable governments to exploit private sector finance, technology and expertise in the expansion of infrastructure.
- They are relatively uncontroversial from a political standpoint, as private sector involvement is generally limited to a specific infrastructure project.

Disadvantages.

The main problem with BOT and BOO contracts are:

- They can be relatively unattractive to the private sector, given the level of capital expenditure and the degree of long term risk,
- They may require considerable preparatory work prior to the award of the contract to select bidders and provide them with adequate revenue forecasts.

Private Sector Perceptions

Advantages.

The main advantages of these options from a private sector perspective are:

- Where the plants are designed to meet demand peaks, and the revenues are consequently likely to be volatile in nature, it is not unusual for the operator to secure some form of “take or pay” arrangement with the downstream user to provide a minimum guaranteed revenue. This has the advantage of insulating the operator from demand-side risk.
- Such contracts represent a relatively small scale and self-contained involvement, compared with the operation of a complete infrastructure network. They can therefore be used to gain experience of working in a particular country or area with a view to developing further business in that country or area.

Disadvantages:

- Potentially high risk with relatively modest returns. The main risk, given the capital-intensive nature of such contracts, is the potential for construction cost over-runs.
- The financial assessment of such projects depends crucially on the quality of the demand forecasts used to project the revenue stream. Where such forecast are inaccurate, or ill conceived, the commercial viability of the project might be seriously jeopardised.
- The maximum revenue is clearly defined by the capacity limits of the plant, so any upside for the operator must come from capital and operating cost reductions.

Performance Monitoring Measures for Solid Waste Collection Operations

There are numerous criteria for performance monitoring of collection and landfill operations, depending upon the complexity of the privatisation option adopted.

The following tables present typical measures that may be incorporated, wither fully or partially, into any such future contracts.

Performance measures	What is measured ?	How is it measured ?	Where is it measured ?	How often is it measured ?	By whom is it measured ?	Basis for sanction ?
Cleanliness of service areas	Existence of litter Existence of ***clandestine*** waste piles Waste in drains Improperly placed waste bins Regularity and frequency of collection service Cleanliness around ***communal*** containers Weekly washing of communal containers Completeness of collection service – number of collection points unserved False loading of vehicle with water, stone, etc. to increase payments	Zone inspection reports Customer complaints register	Service zones	Daily	Assemblies Districts[1]	Yes
Safe disposal of collected wastes	Waste quantity delivered at official site Clandestine dumping	City-wide inspections Records at disposal site Complaints by witnesses of clandestine dumping	City-wide Disposal sites	Daily	Assemblies Districts	Yes
Customer satisfaction	Perception about cleanliness of zone Willingness to pay Willingness to participate with collection requirements	Surveys of customer satisfaction Surveys of willingness to pay	Service zones	Semi-annually	Assemblies Districts	No
Customer dissatis-faction	Complaints about improperly placed waste bins, damage of waste bins, uncollected wastes, rude behavior by collectors, poor appearance of collection vehicle and collection crew.	Zone inspection reports Records of complaints Records of follow-up of complaints Records on attainment of service frequency targets	Service zones	Weekly	Assemblies Districts	Yes
Worker productivity	Number of workers in service Waste quantity per worker each shift Absenteeism	Zone inspection reports Records at disposal sites Vehicle log books	Service zones Disposal sites	Weekly	Assemblies	No
Vehicle productivity	Number of vehicles in service Waste quantity per vehicle each shift Waste quantity per vehicle each day Vehicle ***downtime***	Records at disposal sites Vehicle log books Zone inspection reports Load inspections at landfill	Service zones Disposal sites	Weekly	Assemblies	No

[1] Each Local Government, whether it be a city, municipality, metropolitan area, or council, has its own terminology for its sub-areas. Assemblies and districts are among the terms most often used for such sub-areas.

Performance measures	***What is measured ?***	***How is it measured ?***	***Where is it measured ?***	***How often is it measured ?***	***By whom is it measured ?***	***Basis for sanction ?***
Recycling achievements	Types of ***secondary*** materials recycled Quantity of secondary materials recycled	Zone inspection reports Records from sales of ***recyclables***	Service zones Records from service provider	Monthly	Assemblies	No
Environmental controls	Exhaust emission control of vehicles ***Sump tank*** control of leakage from wastes in vehicles Control of litter from vehicles Washing of vehicles	Vehicle emission inspection reports Zone inspection reports Complaints about vehicle emissions and litter	Service zones Records from service provider	Weekly	Assemblies Districts	Yes
Occupational health and safety controls	Use of gloves Use of respiratory masks Use of uniforms Tools on vehicle to load loose waste Annual medical checks Provision of vaccinations Control over size and weight of lifted loads Operational status of vehicle lights (night lights, brake lights, and reversing lights) Number of accidents Adequate accident liability coverage (insurance)	Zone inspection reports Survey of workers Medical records Accident records Insurance policies	Service zones Records from service provider	Weekly	Assemblies	Yes
Fair labor practices	Wages paid - minimum or above Payment for overtime Medical expenses coverage Vacation and holiday allowances Adequacy of work breaks Proper hiring and justifiable termination procedures	Zone inspection reports	Service zones Records from service provider	Monthly	Assemblies	Yes
Hazardous waste segregation	Refusal to collect ***hazardous*** waste Provision of special collection for household hazardous waste	Zone inspection reports Inspection of loads at disposal sites	Service zones Disposal sites Records from service Provider	Monthly	Assemblies Districts	Yes
Fuel consumption	Fuel records showing consumption – per kilometer and per tonne Maintenance records on engine calibration Route rationalization	Vehicle log books Workshop vehicle records Zone inspection reports Route plans	Service zones Records from service provider	Monthly	Assemblies	No

Performance measures	*What is measured ?*	*How is it measured ?*	*Where is it measured ?*	*How often is it measured ?*	*By whom is it measured ?*	*Basis for sanction ?*
Reliability	Downtime of vehicles Number of accidents Worker strikes Absenteeism, illness and accidents of workers	Vehicle log books Workshop's vehicle records Medical records	Service zones Records from service provider	Monthly	Assemblies	No
Communi-cation	Notification of service problems Continuous radio accessibility Use of designated routes so vehicles can be located	Correspondence files Zone inspection reports Radio functioning between all trucks and central offices Adherence to route plans	Letters from service provider	Monthly	Assemblies	No
Finance	Payment of government property, income, VAT, and corporate taxes, etc., as required Regular payment of fair wages and benefits to workers	Financial records Reports of independent auditor	Records from service provider	Yearly	Assemblies	Yes

Performance Monitoring Measures for Solid Waste Landfill Operations

Performance measures	*What is measured ?*	*How is it measured ?*	*Where is it measured ?*	*How often is it measured ?*	*By whom is it measured ?*	*Basis for sanction ?*
Quantity of waste received for landfill	Waste quantity per shift Waste quantity per day	Landfill inspection reports Landfill records Vehicle log books Zone inspection reports	Landfill	Daily	Assemblies Districts	No
Construction of landfill base according to design	Compaction of base soils at optimum moisture Slope of base soils Placement and sealing of imperme-able ***liners*** Placement and slope of ***leachate*** collection system	Survey instruments observed to be used during construction Construction inspection reports	Landfill	During construction	Assemblies	Yes
Construction of landfill cell according to design	Daily delineation of ***working face*** boundaries Survey of coordinates and elevations of daily ***cell*** construction, including slope of working face Continuous on-site availability of design drawings and O&M manual Closure of cell when final design elevation is reached Respect of maximum angle for side slopes Respect of minimum requirement for base slopes	Survey instruments observed to be used daily Marking up of daily progress in cell construc-tion on design drawings Topographic survey map of completed cell area when final design elevation is reached	Landfill	Daily	Assemblies	Yes

Performance measures	***What is measured ?***	***How is it measured ?***	***Where is it measured ?***	***How often is it measured ?***	***By whom is it measured ?***	***Basis for sanction ?***
Adequacy of internal access roads	Roads free of waste Roads usable in all weathers Adequate drainage to keep roads free of flooding	Vehicle log books (Operational delays of collection vehicles at landfill) Landfill inspection reports	Landfill	Daily	Assemblies Districts	No
Cleanliness of access routes to landfill	Litter Clandestine waste piles Waste in drains Improperly placed waste bins	Zone inspection reports	Service Zones	Daily	Assemblies Districts	Yes
Residents' and private haulers' satisfaction with landfill	Perception about environmental acceptability of landfill operation Willingness to pay Willingness to participate with service requirements	Surveys of customer satisfaction Surveys of willingness to pay	Area around landfill All haulers	Semi-annually	Assemblies Districts	No
Residents' dissatisfaction with landfill	Complaints about landfill noise, dust, odor, traffic, appearance and increase in ***vectors***	Inspection reports Records of complaints	Area around landfill	Monthly	Districts	Yes
Private haulers' dissatisfaction with landfill	Complaints about landfill noise, dust, odor, traffic, appearance Complaints about delays suffered by collection vehicles at landfill, damage to vehicles and tires, inappropriate tipping fee charges, operation of ***weighbridge***, difficulty in driving to working face	Inspection reports Records of complaints Records of follow-up to complaints	All haulers	Monthly	Assemblies	Yes
Worker productivity	Number of workers in service Waste quantity per worker and shift Absenteeism	Landfill inspection reports Records at landfill	Landfill	Weekly	Assemblies	No
Equipment productivity	Number of equipment units in service Waste quantity per equipment unit each shift Waste quantity per equipment unit each day Equipment downtime	Landfill inspection reports Records at landfill	Landfill	Weekly	Assemblies	No
Recycling achievements	Types of ***secondary*** materials recycled Quantity of secondary materials recycled	Landfill inspection reports Records from sales of recyclables	Landfill	Monthly	Assemblies	No

Performance measures	***What is measured ?***	***How is it measured ?***	***Where is it measured ?***	***How often is it measured ?***	***By whom is it measured ?***	***Basis for sanction ?***
Environmental controls	Control of equipment exhaust emissions Windblown litter Dust Noise Control of area of ***working face*** Daily compaction of deposited waste Use of adequate daily cover at the end of each day's work Washing of equipment Flies, rodents, birds Leachate treatment and discharges Control of landfill gas Drainage of surface water – adequacy and maintenance Presence of unauthorized people or animals Presence of ***hazardous*** wastes Recording of all collected waste loads Provision and maintenance of an attractive vegetative ***buffer*** around operational areas	Equipment emission inspection reports Landfill and area inspection reports Complaints about emissions, noise, dust and litter Fly count, rodent count, bird count Pesticide application records Size of daily refuse cell Monitoring of ***leachate*** treatment plant discharges Groundwater and surface water monitoring Monitoring of landfill gases Records of incoming waste loads	Landfill and surrounding area	Weekly	Assemblies Districts	Yes
Hazardous waste segregation	Refusal to accept industrial or commercial hazardous waste Provision of special collection and storage area for household hazardous waste	Landfill inspection reports Inspection of loads at disposal sites	Landfill Disposal sites Records from service provider	Monthly	Assemblies	Yes
Fair labor practices	Wages paid - minimum or above Payment for overtime Medical expenses coverage Vacation and holiday allowances Adequacy of work breaks Proper hiring and justifiable ***termination*** procedures	Landfill inspection reports Survey of workers	Landfill Records from service provider	Monthly	Assemblies	Yes

Performance measures	*What is measured ?*	*How is it measured ?*	*Where is it measured ?*	*How often is it measured ?*	*By whom is it measured ?*	*Basis for sanction ?*
Occupa-tional health and safety controls	Use of gloves and boots Use of respiratory masks Functioning air conditioning on all equipment units Adequacy of roll-bars Replacement of filters on air conditioners Use of uniforms Annual medical checks Provision of vaccinations Control over size and weight of lifted loads Number of accidents Health and safety training of all landfill personnel Practice of emergency and evacuation procedures Continuous presence and functionality of fire protection and other emergency equipment Continuous on-site presence of health & safety manual Posting of health & safety telephone numbers Adequate accident liability coverage Operational night-time illumination Reversing lights and audio signals on all equipment	Landfill inspection reports Survey of workers Medical records Accident records Inspection of equipment units Insurance policies	Landfill Records from service provider	Weekly	Assemblies	Yes
Fuel consumption	Fuel records on consumption – per hour and per tonne Maintenance records on engine calibration	Equipment log books Equipment maintenance reports	Landfill Records from service provider	Monthly	Assemblies	No
Reliability	***Downtime*** of equipment Number of accidents Number of slides, erosion events Worker strikes Worker illness and accidents	Equipment log books Landfill inspection reports	Landfill Records from service provider	Monthly	Assemblies	No
Communica-tion	Notification of service problems Continuous accessibility by radio	Correspondence files Landfill inspection reports Radio functioning between landfill and central offices	Letters from service provider	Monthly	Assemblies	No
Finance	Payment of government property, income, VAT, and corporate taxes, etc., as required Regular payment of fair wages and benefits to workers	Financial records Independent auditor reports	Records from service provider	Yearly	Assemblies	Yes

Performance Monitoring Measures for Solid Waste Landfill Operations

Performance measures	*What is measured ?*	*How is it measured ?*	*Where is it measured ?*	*How often is it measured ?*	*By whom is it measured ?*	*Basis for sanction ?*
Quantity of waste received for landfill	Waste quantity per shift Waste quantity per day	Landfill inspection reports Landfill records Vehicle log books Zone inspection reports	Landfill	Daily	Assemblies Districts	No
Construction of landfill base according to design	Compaction of base soils at optimum moisture Slope of base soils Placement and sealing of impermeable ***liners*** Placement and slope of ***leachate*** collection system	Survey instruments observed to be used during construction Construction inspection reports	Landfill	During construction	Assemblies	Yes
Construction of landfill cell according to design	Daily delineation of ***working face*** boundaries Survey of coordinates and elevations of daily ***cell*** construction, including slope of working face Continuous on-site availability of design drawings and O&M manual Closure of cell when final design elevation is reached Respect of maximum angle for side slopes Respect of minimum requirement for base slopes	Survey instruments observed to be used daily Marking up of daily progress in cell construction on design drawings Topographic survey map of completed cell area when final design elevation is reached	Landfill	Daily	Assemblies	Yes

Performance measures	*What is measured ?*	*How is it measured ?*	*Where is it measured ?*	*How often is it measured ?*	*By whom is it measured ?*	*Basis for sanction ?*
Adequacy of internal access roads	Roads free of waste Roads usable in all weathers Adequate drainage to keep roads free of flooding	Vehicle log books (Operational delays of collection vehicles at landfill) Landfill inspection reports	Landfill	Daily	Assemblies Districts	No
Cleanliness of access routes to landfill	Litter Clandestine waste piles Waste in drains Improperly placed waste bins	Zone inspection reports	Service Zones	Daily	Assemblies Districts	Yes
Residents' and private haulers' satisfaction with landfill	Perception about environmental acceptability of landfill operation Willingness to pay Willingness to participate with service requirements	Surveys of customer satisfaction Surveys of willingness to pay	Area around landfill All haulers	Semi-annually	Assemblies Districts	No
Residents' dissatisfaction with landfill	Complaints about landfill noise, dust, odor, traffic, appearance and increase in ***vectors***	Inspection reports Records of complaints	Area around landfill	Monthly	Districts	Yes
Private haulers' dissatisfaction with landfill	Complaints about landfill noise, dust, odor, traffic, appearance Complaints about delays suffered by collection vehicles at landfill, damage to vehicles and tires, inappropriate tipping fee charges, operation of ***weighbridge***, difficulty in driving to working face	Inspection reports Records of complaints Records of follow-up to complaints	All haulers	Monthly	Assemblies	Yes
Worker productivity	Number of workers in service Waste quantity per worker and shift Absenteeism	Landfill inspection reports Records at landfill	Landfill	Weekly	Assemblies	No
Equipment productivity	Number of equipment units in service Waste quantity per equipment unit each shift Waste quantity per equipment unit each day Equipment downtime	Landfill inspection reports Records at landfill	Landfill	Weekly	Assemblies	No
Recycling achievements	Types of ***secondary*** materials recycled Quantity of secondary materials recycled	Landfill inspection reports Records from sales of recyclables	Landfill	Monthly	Assemblies	No

Performance measures	What is measured ?	How is it measured ?	Where is it measured ?	How often is it measured ?	By whom is it measured ?	Basis for sanction ?
Environmental controls	Control of equipment exhaust emissions Windblown litter Dust Noise Control of area of ***working face*** Daily compaction of deposited waste Use of adequate daily cover at the end of each day's work Washing of equipment Flies, rodents, birds Leachate treatment and discharges Control of landfill gas Drainage of surface water – adequacy and maintenance Presence of unauthorized people or animals Presence of ***hazardous*** wastes Recording of all collected waste loads Provision and maintenance of an attractive vegetative ***buffer*** around operational areas	Equipment emission inspection reports Landfill and area inspection reports Complaints about emissions, noise, dust and litter Fly count, rodent count, bird count Pesticide application records Size of daily refuse cell Monitoring of ***leachate*** treatment plant discharges Groundwater and surface water monitoring Monitoring of landfill gases Records of incoming waste loads	Landfill and surrounding area	Weekly	Assemblies Districts	Yes
Hazardous waste segregation	Refusal to accept industrial or commercial hazardous waste Provision of special collection and storage area for household hazardous waste	Landfill inspection reports Inspection of loads at disposal sites	Landfill Disposal sites Records from service provider	Monthly	Assemblies	Yes
Fair labor practices	Wages paid - minimum or above Payment for overtime Medical expenses coverage Vacation and holiday allowances Adequacy of work breaks Proper hiring and justifiable ***termination*** procedures	Landfill inspection reports Survey of workers	Landfill Records from service provider	Monthly	Assemblies	Yes

Performance measures	*What is measured ?*	*How is it measured ?*	*Where is it measured ?*	*How often is it measured ?*	*By whom is it measured ?*	*Basis for sanction ?*
Occupational health and safety controls	Use of gloves and boots Use of respiratory masks Functioning air conditioning on all equipment units Adequacy of roll-bars Replacement of filters on air conditioners Use of uniforms Annual medical checks Provision of vaccinations Control over size and weight of lifted loads Number of accidents Health and safety training of all landfill personnel Practice of emergency and evacuation procedures Continuous presence and functionality of fire protection and other emergency equipment Continuous on-site presence of health & safety manual Posting of health & safety telephone numbers Adequate accident liability coverage Operational night-time illumination Reversing lights and audio signals on all equipment	Landfill inspection reports Survey of workers Medical records Accident records Inspection of equipment units Insurance policies	Landfill Records from service provider	Weekly	Assemblies	Yes
Fuel consumption	Fuel records on consumption – per hour and per tonne Maintenance records on engine calibration	Equipment log books Equipment maintenance reports	Landfill Records from service provider	Monthly	Assemblies	No
Reliability	***Downtime*** of equipment Number of accidents Number of slides, erosion events Worker strikes Worker illness and accidents	Equipment log books Landfill inspection reports	Landfill Records from service provider	Monthly	Assemblies	No
Communication	Notification of service problems Continuous accessibility by radio	Correspondence files Landfill inspection reports Radio functioning between landfill and central offices	Letters from service provider	Monthly	Assemblies	No
Finance	Payment of government property, income, VAT, and corporate taxes, etc., as required Regular payment of fair wages and benefits to workers	Financial records Independent auditor reports	Records from service provider	Yearly	Assemblies	Yes

Appendix M - Evaluation and Diagnosis

Background

The monitoring and evaluation of the solid waste management program include detailed recording and assessments of the day-to-day operations. It is important to consider all costs incurred, and what category they fall in to. This is important to assess where resources need to be allocated, or conversely, where program changes might be able to reduce costs.

Secondly, both qualitative and quantitative evaluations of the working of the system need to be made. The assessment of the success of the ISWMP depends upon records of the amount of solid waste collected, frequency of collections of both secondary and primary secondary waste points, cleanliness of the various parts of the systems, and general effectiveness of the program.

Monitoring and Evaluation spreadsheets required would include as a minimum:

- Monthly Landfill Operations: Costs and Evaluation
- Monthly Secondary System: Costs and Evaluation
- Monthly Primary Collection: Costs and Evaluation
- Monthly Primary Storage: Costs and Evaluation

The costs and evaluations information needs to be recorded on a daily basis and turned in to the MSW manager on a weekly basis. The manager should summarize the monthly information and prepare a report to the Mayor on a monthly basis.

Steps in Implementation

A ISWM Plan needs to be flexible and capable of modification and adjustment. Over time, plans need to take into account external influences such as availability of funding and resources and interaction with other areas of City activity and policy. The plan must also be strongly managed to ensure successful implementation.

The action plan should focus a short-term action plan and a longer ten year action plan period. The short-term action plan could be based on a 12-month period with two streams of activity.

- Immediate actions which are required to ensure progress could be made during the first year of the strategy;
- Building for the strategy which will involve a period of consensus building with the aim to bring to politicians firm proposals for implementation of the long term strategy;

Implementation of the ISWM plan is likely to require the responsible authority to adapt its structure and resources to suit changing managerial requirements as ISWM projects are developed. Having developed the plan, the process of practical implementation must begin and it is important that the City follows through a logical sequence of steps to ensure successful implementation.

There are a number of examples of good practice that will aid implementation of ISWM plans, particularly for municipal solid waste agencies in low-income countries where comprehensive technical and institutional approaches have not previously been implemented. These include:

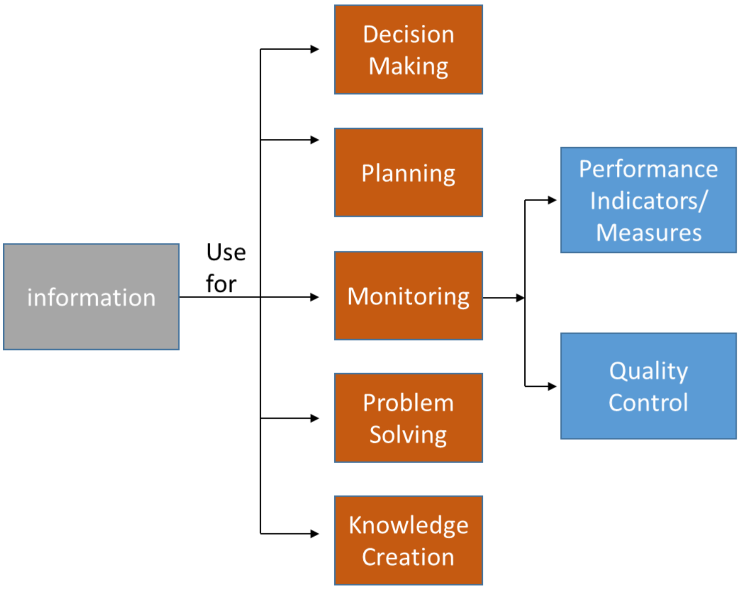
- Communication and evaluation is vital between the City and donor agencies, supervising consultants and among on-the-ground parties in the project are. In many cases inadequate communication and consultation cause project delays.

- Particular attention needs to be paid to the writing of procurement specifications for vehicles and equipment. The need to select appropriate MSW collection vehicles and other equipment has previously been reviewed.
- It is important a solid waste management expert or Working Group (Reporting to the ISWM Committee) is assigned to the implementation stage of the plan. Where the plan involves implementation of a number of technical projects (e.g. development of transfer stations and landfill sites) it may be appropriate for an expert to be on hand at each project location. The expert (or project officer) may well be assigned to the project area for periods of up to several years. In this way continuity is guaranteed between the project planning and project implementation stages.

The process of ISWM action plan implementation must be monitored and regularly reviewed in order to identify weaknesses in the program and to identify actions to update the process. The following sections discusses this aspect of plan evaluation using indicators and measures of ISWM performance and with reference to specific worked examples of implementation monitoring.

Performance Monitoring For Solid Waste Management Services

Throughout this Plan the need for collecting and utilising information has been stressed. Large amounts of data are being collected and processed into useable information. But it has to be kept in mind that information *per se* is only valuable when it is focused and being used to a specific end. The diagram below shows the various possible uses of information.



- **Figure Use of Information**

Why Improve Performance Monitoring?

The monitoring tools frequently used to assess performance of the ISWM system are, among others,

- visual observations;
- general feed-back from the work force; or
- customer complaints.

Such observations can lead to inaccurate and unquantifiable results and present an insufficient basis for making planning decision for system improvement. Additionally, at first sight seemingly obvious reasons for an unsatisfactory performance of a ISWM function, may, through a more detailed and formal analysis, turn out to not be the reasons at all for the problems.

Lack of funds, for example, is often seen as the reason for low performance of components of the ISWM system in a City. A detailed analysis might reveal that performance could be much improved through improved routing, staffing, more effective management or use of alternative vehicles. An improved planning process, also, will most likely lead to increases in effectiveness and efficiency of the service.

Monitoring the performance of a municipal ISWM system has a number of goals:

- To closely observe the quality of the ISWM service provided in order to maintain or improve service quality;
- To encourage the efficient use of available resources;
- To relate the outputs of a service to inputs (and ultimately their cost);
- To improve service quality overall and relative to cost;
- To enforce accountability of service providers;
- To put downward pressure on cost of service provision;
- To compare and assess services provided against the targets set out in municipal ISWM plan;
- To provide information on which management can make policy and management decision about the service;
- To compare the service provided between two or more sub-municipalities or municipalities in a regional association;
- To compare the quality of service provision in a City with a previous month or year;
- To monitor and evaluate the quality of services provided by private service contractors.

Performance analysis is a key element in the process of providing good quality, value-for-money services. It is a process by which the efficiency of a service can be monitored and compared with similar services offered elsewhere or at an earlier time. Performance review needs to be an integral part of any ISWM process.

The two central questions of ISWM performance monitoring are:

- How effective is the ISWM service that is being provided? Meaning: To what extend does the system presently in place satisfy the need for a ISWM service and where is improvement required?
- How efficient is the ISWM service provided? Meaning: Are we using the available resources in the best possible way and how can we improve their use?

Effectiveness and efficiency are closely related, increases in efficiency lead in most scenarios to increases in effectiveness, provided resources are not cut simultaneously.

In summary,

- we need to know whether we use our money, people and equipment in the best possible way to serve the greatest amount of customers at the highest possible standards, and

- we need to know where the weak points in our present system are to enable us to take steps for implementing improvement.

Definitions of Performance Indicators and Measures

In order to determine the performance of a municipal solid waste management system in general, and its individual components in specific, data and information called "performance indicators" and "performance measures" of ISWM are used.

Performance Indicators – are quantitative data related to ISWM services such as:

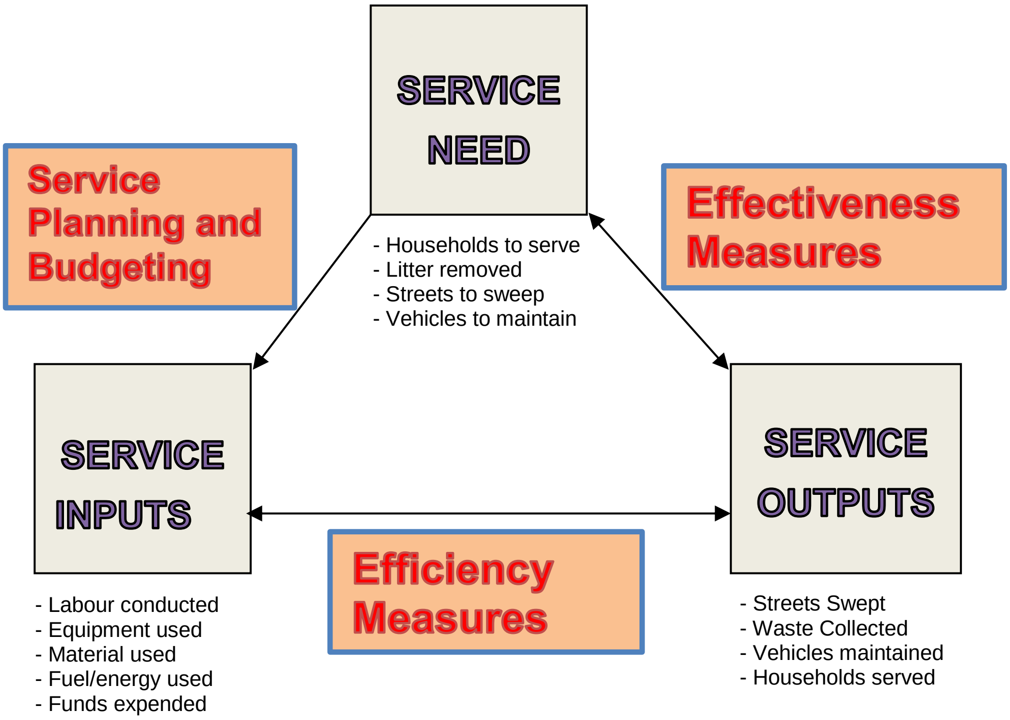
- Number of businesses to be served,
- Kilometres of streets to collect from, or
- Number of employees in service.

Performance Measures – are the result of processing indicators, by relating them to either time or cost, and are the principle tool for assessing the performance of the system under review. For example:

- Cost per ton disposed;
- Number of streets swept per hour etc.

In order to obtain reliable performance measures, the following is needed:

- Accurate, reliable and regular data collection;
- Accurate and reliable cost accounting procedures;
- Weighing of wastes;
- Availability of service operating detail;
- Units to which the performance indicators can be related (e.g. costs per 1000 of population served, costs per household served, time per tonne of waste collected etc.)



- **Indicators and Performance Measures**

Performance Indicators and Measures for ISWM System Analysis

While there are a number of specific performance measures that can be used to assess the individual functional elements or any ISWM system, there are also measures that help gauge the overall performance of the ISWM sector.

As with the performance measures especially focusing on particular functional elements of the system, these general sector performance measures have to be compiled at regular intervals and then be compared over time to enable planners to monitor and detect positive and negative trends in the sector. If for example the billing index (Billing index (%): Number of commercial premises that receive bills divided by number of premises served multiplied by 100) goes down steadily over time, this could be the signal for the ISWM department to revisit the existing billing system for commercial/industrial waste and find ways of improving it.

The following is a summary overview of performance, management and general measures related to ISWM.

- **Overview of performance, management and general measures related to ISWM**

Issues	Indicator
Health	Morbidity and mortality rates due to illnesses related directly or indirectly, with solid wastes, such as, cholera, tetanus, dengue fever, teniasis, hepatitis etc., by urban and peri-urban zones.
Economy	Number of workers employed in the solid wastes sector.
	Number of large, middle, and small companies involved in urban sanitation (fabrication of mechanical equipment, contracting firms of urban sanitation, recycling industries, consulting agencies, maintenance shops, and others)
	Weight percentage of solid wastes recovered over the total of solid wastes generated.
	Increase in the number of tourists relative to the previous year.
Environmental Conditions	Weight percentage of SW collected over SW generated.
	Weight percentage of SW properly disposed over SW collected.
Social Conditions	Percentage of peri-urban population provided with collection services over total peri-urban population.
	Annual increase/decrease in separators in final disposal (last 5 years).
	Number of community health education programs.
Solid Wastes Generation	Per capita production (kg/person/day): Total tonnage of solid wastes collected per day divided per thousand served.
Recovery	Tonnage of solid wastes recovered per day divided by tonnage of solid wastes generated per day multiplied by 100.
Coverage and Access to Urban Sanitation Services	Urban collection: Urban population served divided by total urban population multiplied by 100.
	Peri-urban collection: Peri-urban population served divided by total peri-urban population multiplied by 100.
	Urban composition: Peri-urban population divided by total urban population multiplied by 100.
Management, Operation and finance:	Number of employees of sanitation service per thousand persons served.
	Rate or tariff of urban sanitation monthly average per home, in Local currency.
	Payment capacity: minimum monthly rate or tariff of urban sanitation versus income or monthly minimum salary (%).
	Budget of sanitation service versus total municipal budget (%).
	Capital investments versus total budget of urban sanitation service (%).
	Income generation through tariffs and rates versus total cost of the service (%).
	Efficiency of collection (%): Value collected divided by value billed multiplied by 100.
	Unit cost of sanitation service (Pesos/ton): Sum of all direct annual costs, indirect costs, social benefits, contract payments, financial costs, depreciation and others divided by tonnage received bat site of final disposal per year.
Other Recommended Indicators:	Coverage of street sweeping (%): length of paved streets swept divided by the total length of paved streets multiplied by 100.
	Efficiency of collection equipment maintenance (%): Total equipment divided by number of equipment in operation + reserve equipment + equipment in maintenance multiplied by 100.
	Number of bills paid per month versus total number of bills issued per month multiplied by 100.
	Billing index (%):

Performance Measures for SW Collection

Examples of performance measures for collection services are shown below. A comprehensive listing is also provided of the basic data that any City department wanting to measure the performance of its collection service can use, and the recommended frequency of data collection for each specific item.

All of the indicators highlighted can be used to compare performance on a year-by-year basis within the City and with other similar municipalities. However, the validity of any of these approaches depends on the availability and accuracy of the authority's information management system, and its ability to provide reliable cost and revenue information, and basic data on waste tonnage, or other measures of service provided. Also, comparisons of performance must take into account local geographic or industrial conditions and the standards of service provided.

Service Provision →	Tonnes/week for each operator People served/week/operator Vehicles availability and off road time Vehicles mileage/day Vehicles operating hours Reserves as a proportion of vehicle fleet Frequency of collection % of population receiving collection services Number of complaints received from public
Financial Performance →	Total collection cost/tonne or household Vehicle cost/tonne or household Labour costs/tonne or household Cleansing tax receipts/tonne or household Total tax collected as a percentage of revenue Revenue collected against cost of collection service Revenue collected from commerce and industry

- **Main Performance Measures for the ISWM Collection Service**

- **Data Collection Requirements for Municipalities to Compile and Report Performance of the Solid Waste Collection Services**

		Recommended Frequency of Data Collection
	Overall Service Provision	
1.	Tonnage collected – weighed or estimated vehicle loads	daily
2.	Population or number of households in area of City waste collection responsibility	yearly
3.	Population or number of households actually collected from	yearly
4.	Frequency of collection services by type, domestic, commercial, clinical etc.	yearly
5.	Number of vehicles in City fleet by type, size, age, make, registration number	monthly
6.	Name of person responsible for solid waste collection service	yearly
7.	Management structure and numbers of persons involved in collection service designated: collection: administration: maintenance	yearly
8.	Number of complaints received from public; nature of complaint and action taken	weekly
	Operational Information	
1.	Number of collection vehicles operating and total vehicle hours worked	daily
2.	Number of persons operating collection service designated: collection administration; maintenance	daily
3.	Vehicle operational records by daily driver worksheet: • Identification of vehicle and driver • Vehicle hours working • Vehicle mileage covered • Vehicle fuel used • Number of vehicle trips to disposal sites • Number of operating personnel in vehicle crew.	daily
4.	Vehicle operating costs by maintenance log for each vehicle: • Identification of vehicle • fuel and oil • tires • routine servicing • maintenance and repairs, recording description, cost and time to complete:	weekly

	• engine and transmission and brakes, hydraulic systems chassis and suspension, body work and glass, other	
	Financial Information	
1.	Vehicle operating costs by vehicle and by fleet	monthly
2.	Labour costs: payroll plus overheads, consumables etc.	monthly
3.	All other solid waste collection department costs	monthly
4.	Total costs presented as full cost of the collection operation: • per ton of waste collected • per person/household served • per number of persons employed in solid waste collection	yearly
5.	Revenues collected from Tax	Twice yearly
6.	Revenues collected from commercial and industrial waste producers • As a total sum • As a revenue per ton collected	Twice yearly

Assessment of Solid Waste Disposal Services

Disposal operations should also be monitored to ensure that manpower and other resources are efficiently and effectively managed at all sites.

Efficiency is again measured by computing unit costs for each operation. However, as with all performance measures, care must be taken to ensure that comparisons are made on a consistent basis. As with collection, the reliability of all performance measures depends on the quality of the information on which they are based: for example, weighing of wastes is essential. Comparisons must be made on a consistent basis, taking into account any geographical or other differences between sites.

It must be remembered that in many countries that, current disposal costs are negligible due to the prevalence of open dumping practices. As such, higher operating costs will result, and therefore funding is essential if services are to improve.

The main performance measures for assessing disposal services are highlighted below.

Service Coverage	Tonnes of waste delivered Density of waste placed Quantity of leachate treated Quality of treated effluent Frequency of daily cover use Number of complaints received from public
Financial Performance	Total disposal cost/tonne Total operational cost Specific operational cost (staff, plant, environmental management, materials, daily cover) Income from sales of recovered materials Transfer costs (where appropriate)

- **Main Performance Measures for the ISWM Disposal Service**

The following Table provides more detail on this issue.

- **Data Collection Requirements for ISWM Disposal Services**

		Recommended Frequency of Data Collection
	Overall Service Provision	
1.	Disposal site locations and type of operations; landfill, incineration, recycling plant etc.	yearly
2.	Tonnage received-weighed or estimated vehicle loads and by waste type and by collection authority: • Domestic • Domestic and commercial • Commercial only • Clinical • Industrial – what type of waste and origin	daily
3.	Vehicles equipment and plant utilised in disposal operations by type, size, age, make, registration number	monthly
4.	Name of person responsible for solid waste collection services	yearly
5.	Management structure and numbers of persons involved in disposal service designated	yearly
6.	Number of complaints received from public: nature of complaint and action taken	weekly
7.	Environmental management at landfill and transfer station sites: pollution incidents, breaches of license conditions, remediation actions, frequency of environmental monitoring	weekly
	Operational Information	
1.	Number of vehicles or equipment operating and total vehicle or equipment hours worked	daily
2.	Number of persons operating disposal or MRF services designated operational administration maintenance	daily
3.	Vehicle or equipment operational records by daily driver worksheet: • Identification of vehicle or equipment and driver • Vehicle or equipment hours working • Vehicle or equipment hours in-operational for maintenance • Vehicle or equipment fuel used	daily
4.	Vehicle or equipment operating costs by maintenance long for each vehicle: • Identification of vehicle or equipment • fuel and oil • tires or tracks • routine servicing	weekly

	• maintenance and repairs, recording description, costs and time to complete: engine, transmission, brakes, hydraulic systems, chassis, suspensions, bodywork, glass, other.	
5.	Leachate management installed on site: • Quantity produced per day – estimated or measures • Type of treatment or disposal • Costs of operation	yearly monthly
6.	Cover material used on site: • how often spread over waste • estimated volume of material used	yearly
7.	Recycling and resource recovery systems and programs in operation by City or private sector materials recovered and method of recovery	yearly
8.	Transfer stations and bulk transportation operations Type, number of vehicles, tonnage transported and mileage covered	yearly
9.	Is there a weighbridge in consistent use at the landfill sites: Records kept of tonnage of waste being disposed.	yearly
	Financial Information	
1.	Plant operation costs for each site	monthly
2.	Labour costs: payroll plus overheads, consumables, etc.	monthly
3.	All other solid waste disposal departmental costs	monthly
4.	Total costs presented as full cost of the disposal operation: • per ton of waste received • per person/household served • per number of persons employed in solid waste disposal	yearly
5.	Revenues from municipalities using disposal service (proportion of Cleansing Tax)	twice yearly
6.	Revenues from receipt of commercial and industrial wastes	monthly
7.	Revenues or grants from any other sources	twice yearly
8.	Revenues from recycling and resource recovery operations	monthly
9.	Transfer and bulk haulage costs if applicable	monthly
10.	Capital repayments on loans for solid waste management projects specify	monthly

Dealing with Information: Management Information System (MIS)

As discussed above, in order to move a waste management system to better performance by increasing its efficiency and effectiveness, the system currently in place has to be assessed and then be continually improved through planning and operational management processes.

A significant part of the resources problem that confronts local government stems from a lack of concern and knowledge about costs, quality and accountability. These problems stem, in part, from the inefficient use of existing resources, and used more efficiently, the same resources could provide better and more comprehensive services. With more, or better-used, information on the ISWM system, its inefficiencies can be removed or diminished. The tool to use to this end is called a Management Information System.

A Management Information System (MIS) is defined as a system in which information is collected, stored, organised, processed, utilised and disseminated.

A MIS is an on-going process, requiring a regular stream of data to be collected and fed into it. It also requires a medium for storage and processing data.

Benefits of a functioning MIS include:

- Though the provision of accurate, relevant, comparable and up-to-date management information, resources can be costed and matched against outputs delivered;
- Annual budget proposals can be made on the basis of actual needs, taking account of changes in service characteristics, costs and revenues;
- Overall revenue requirements can be better established and politically and socially acceptable charging schemes be devised;
- Revenue collections can be improve through better mobilisation of resources;
- Financial performance can be monitored against objectives;
- Investment planning and decision making procedures can be improved; and
- Information about the total cost and cost effectiveness of service provision give the ISWM department a basis to judge performance on a comparative basis against specified criteria, and gives a guide to future investment requirements.

The collection of management information is not an end in itself. Performance indicators must provide signals for action. Data gathering is a costly and time consuming exercise and if the following basic points are not considered in detail before the data gathering begins, it is possible to end up with large amounts of data, that are either unnecessary or cannot be interpreted.

There are different reports needed that summarise the result of performance measuring. For general planning purposes, and as a basis for updates of the ISWM plan, annual or bi-annual summary reports will be sufficient.

At the other end of the scale, routine management reports will be needed for upper level ISWM managers on a weekly or monthly basis, while operational managers will need daily indication of the progress of general operations.

In summary, as the Municipal support systems improve, the ISWM data should be placed on the MIS.

Revising and Updating the ISWM Plan

The process of ISWM plan review should be regularly undertaken in a planned and scheduled fashion. A regular review of the progress with implementation of the action program is necessary to ensure that targets are being met in terms of service delivery, financial performance et.

The action plan needs to be flexible and there may be a need for the implementation program to adapt to changing circumstances and conditions, such as, for example, changes in the waste stream (e.g. through increased affluence), development of new technologies to treat and dispose of waste, or institutional changes.

A program of regular review can help to increase the City's knowledge and understanding of the ISWM system through a process of interactive review, problem diagnosis and development of remedial action programs.