<u>Draft</u>

Resolution of the Government of Georgia №

February --- 2016

Tbilisi

On Approval of
TECHNICAL REGULATION
On MUNICIPAL WASTE COLLECTION AND TREATMENT RULE

Article 1.

According to Product Safety and Free Movement Code Article 58 Part 2, Waste Management Code Article 49, Part 2, subparagraph “b” and Georgian Law on “Normative Acts” Article 12 approve the attached Technical Regulation “On Municipal Waste Collection and Treatment Rule” including attachments.

Article 2.

The Minister of Environment and Natural Resources Protection shall issue a Decree on Approval of Municipal Waste Management Plan Preparation Guideline prior to December 1, 2016.

Article 3.

1. Article 1 of the Resolution to become effective from January 1, 2018.

2. Article 2 of the Resolution to become effective upon issuing.

Prime Minister **Giorgi Kvirikashvili**

TECHNICAL REGULATION
MUNICIPAL WASTE COLLECTION AND TREATMENT RULE

Article 1 - Purpose and Objectives of this Technical Regulation

1. The Municipal Waste Collection and Treatment Technical Regulation (herewith referred to as the Technical Regulation) stipulates the requirements and minimum criteria for collection and treatment of municipal waste in accordance with Article 16, Part 5of the Waste Management Code.
2. This Technical Regulation establishes:
    a) Procedures and requirements for providing effective collection services to all municipal waste generators in a municipality to minimize impact on human health and the environment related to possible effects on local surface water, groundwater, soil and air (including global environmental effects through mitigation of climate change related emissions);
    b) Measures aimed at eliminating possible nuisance conditions such as noise, odors or other adverse effects associated with improper waste collection processes;
    c) Measures aimed at reducing the use of natural resources through recovery and recycling initiatives that displace the need for natural resources in manufacturing new products:
    d) Minimum technical and performance criteria for collection and treatment systems, services and facilities.

Article 2 - Scope of Application

This Technical Regulation shall apply to all collection and treatment processes associated with the management of municipal waste.

Article 3 - Definitions

1. The terms

used for the purposes of this Technical Regulation have the following meaning:

a) **Collection System Design** means a variety of collection system characteristics including, among other things, type and location of containers, types of trucks and the routes followed in providing collection services, preventative maintenance programs for mechanized equipment and the data gathering system associated with the collection system.
b) **Communal Containers** means street containers or secondary storage. These are containers for municipal solid waste provided by the collection agency such that each one is used by by the whole population or by several households;
c) **Economic Life** means the period of time over which a vehicle should be depreciated.
d) **Isolated Settlement** means a settlement where the distance to the nearest urban agglomeration with at least 250 inhabitants per square kilometer is not less than 50 km, or with difficult access by road to those nearest agglomerations due to harsh topography or meteorological conditions during a significant part of the year;
e) **Landfill Operator** means the physical or legal person responsible for the management of a landfill. This person may be different in the various stages of the landfill life cycle including its development, operational, closure and after-care status;
f) **Level of Waste Treatment** means the extent which a treatment process will alter the physical, chemical and biodegradable characteristics of waste for a beneficial purpose;
g) **Points of Collection** means the locations where waste generator disposes waste for its further collection by waste collector;;

h) **Service Coverage** means the geographical extent of waste collection service provision and the proportion of an urban population that receives the collection service expressed as a percentage of the total population.

i) **Street Sweeping Waste** means waste derived from the sweeping and cleaning of streets and public places and from the cleaning of open storm drains within a municipality;

j) **Waste Collector** means a waste holder responsible for the gathering of waste, including the preliminary sorting and preliminary storage of waste for the purposes of transport to a transfer station, landfill or waste treatment facility;

k) **Ministry** means the Ministry of Environment and Natural Resources of Georgia;

2. The definitions presented in Article 3 of the Waste Management Code are used for the purposes of this Technical Regulation.

Article 4 - Principles of Waste Management Applied

1. Municipalities shall carry out all activities associated with waste collection and treatment in compliance with the waste management principles presented in Article 5 of the Waste Management Code.
2. Municipalities shall manage municipal waste in a manner that does not have a negative impact on the environment or human health.

Article 5 – Rights and Obligations of Municipality In accordance with Article 16, Part 1 and Article 6, Part 8 of the Waste Management Code and this Technical Regulation, municipalities shall ensure:

a) Municipal waste collection and establishment of a collection system for this purpose and ensure its effective operation;

b) Transportation of the municipal waste collected within their administrative borders only to treatment and disposal facilities that are permitted for receiving such waste.

c) Facilitating municipal waste treatment.

d) The gradual introduction and proper operation of separate municipal waste collection system.

2. In accordance with Article 13 of the Waste Management Code, municipalities shall be responsible for developing and implementing a five-year municipal waste management plan. This municipal waste management plan shall completely define municipal collection and treatment activities provided by legislation .
3. Municipal waste shall be collected and treated in accordance with the performance criteria and methodology presented in Annex 1 and 2 of this Technical Regulation.
4. Municipalities are entitled to create, implement and manage a joint municipal waste management system.
5. Municipal waste management plans shall comply with the National Waste Management Strategy and Action Plan and waste management plans for separate types of waste (if any).
6. Long term municipal waste planning shall be accomplished in a manner to ensure gradual increase of waste collection service coverage to the entire municipal population in accordance with the National Waste Management Strategy.

7. Municipalities must develop and implement an effective public education and awareness program; the design of which should help ensure the cooperation of waste generators in utilizing the collection system particularly as it relates to the use of designated Points of Collection.

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Article 6. Municipal Waste Collection Service

1. A municipality is directly responsible for municipal waste collection service. Municipality is authorized to hire another person to implement waste collection service as stipulated in the Waste Management Code and the present Technical Regulation.
2. A municipality shall determine the terms of the agreement made with the person stipulated in the first paragraph of the present Article.
3. Municipalities shall provide an effective and convenient collection system for all residential and other municipal waste generators that do not provide their own collection and transport services.
4. In developing their municipal waste management plans, municipalities shall define the means by which they will provide universal collection coverage within their administrative boundaries in accordance with Waste Management Code and the present Technical Regulation.

Article 7 - Collection and Treatment Service Provider

1. Persons implementing waste collection, transportation and/or treatment activities shall possess the necessary permit and registrations according to the requirements of the Regulation of the Georgian government on “Rules and conditions of waste collection, transportation, pre-treatment and temporary storage”.
2. Persons stipulated in the first paragraph of the present Article shall undertake the responsibility to generate records and submit required reports to the Ministry in accordance with the requirements of the Regulation #422 of the Georgian government on Form and Content of Conducting Waste Recording and Reporting dated by August 11, 2015.

Article 8 - Alternative Approaches for Collection

Municipalities and other collection service providers may utilize alternative design methodologies along with the existing method (collection using the communal containers) for collection and so long as the selected methodology complies with Annex 1 of this Technical Regulation and does not cause any harm to human health and the environment.

Article 9. Planning and Implementation of the collection system

1. When planning and implementing an efficient municipal waste collection system, a municipality and other providers of waste collection service need to consider:
   a) Characteristics of waste to be collected and waste collection system coverage zone;
   b) Selection of a municipal waste collection technique that is efficient and compatible with local geographical and socio-economic conditions of the municipality where service is provided;
   c) Peculiarities of a landscape of a city, village or borough within the service that may to a certain exten affect municipal waste collection methods within various areas of a municipality.
2. According to the present Technical Regulations, a municipality shall ensure:

a) Efficient municipal waste collection service provision within the municipality's administrative borders taking into account its financial resources;
b) Improvement and expansion of a municipality's existing collection system based on consideration of the experience.
c) Introduction of an efficient waste collection system based on the modern cost-benefit practice of service implementation;
d) Using collection vehicles and containers ensuring economical, quality and stable service;
e) Cooperation with population and organizations it serves which comes to their participation in introduction of a separate system and use of communal containers;
f) Obtaining sufficient information on operation and maintenance of the existing system in order to develop municipal waste collection system. This will identify the need for planning its long-term efficiency and sustainable investment including timely replacement of equipment;
g) Collection of appropriate information related to municipal waste collection to submit to the Ministry or other governmental agencies;
h) Periodic investments in replacement equipment (vehicles and containers) as needed to sustain the collection system at the desired and effective level of service;
i) Ensuring sustainable technical and management capacities for the purpose of continuous and efficient functioning of the municipal waste collection system.

3. In planning and design of municipal collection and transport systems, municipalities shall define limitations that may exist in providing efficient and adequate collection and transport services. At a minimum, municipalities shall address the following issues:
    a) Inadequate resource mobilization;
    b) Overreliance on imported equipment;
    c) Inappropriate and insufficient sources of finance;
    d) Use of inappropriate technology;
    e) Lack of managerial and technical capacity
    f) Inequity in service provision.

Article 10- Municipal Waste Collection Service Quality

1. Municipalities and other collection service providers shall provide an effective level of collection service designed for maximum convenience for waste generators and to prevent litter conditions at collection container locations.
2. All collection services shall be designed and implemented to provide efficient and reliable service under all physical conditions (population distribution, topography, climatic, etc.) unique to the municipality's collection service area.
3. To the degree possible, all equipment (collection vehicles, containers, etc.) utilized in a municipal waste collection system shall be standardized and appropriate for the physical characteristics of the collection locations.
4. To ensure ongoing effectiveness of the waste collection service, municipality or other collection service providers must adopt and utilize an operation program for all collection equipment to identify the need for equipment maintenance and replacement to sustain the effectiveness of the collection system and ensure performance monitoring.

Article 11- Separate Collection of Recoverable Waste Components

1. As stipulated in Article 16 of the Waste Management Code and the National Waste Management Strategy and Action Plan, municipalities shall provide for the gradual introduction and operation of independent waste collection systems to achieve separate collection of municipal waste components with recovery and recycling value.
2. To facilitate or improve municipal waste recovery potential, separately collected waste components shall not be mixed with other waste or other material with different properties so as to avoid cross-contamination.
3. Municipalities shall take measures to promote high quality recycling and, to this end, shall establish a process for separate collection of selected waste components that is:
   a) Technically, environmentally and economically practicable; and
   b) Appropriate to meet the necessary quality standards for relevant markets for the separately collected materials.
4. Subject to the criteria established in the National Waste Management Strategy and Action Plan and Municipal Waste Management Plans, separate collection shall be established for, at a minimum: paper, metal, plastic and glass.

Article 12. Municipal Waste Streams

At a minimum, municipalities shall generate and utilize the following information in making any design or service optimization decisions:

a) The average weight of waste produced each day per capita or per household in the area to be serviced and population data to develop an estimate of the total weight of waste to be collected each day.
b) The expected density of the waste after loading into a collection vehicle.
c) The amount of biodegradable waste that may influence frequency of waste collection;
d) The inert content of the waste (sand, clay, etc.)
e) Content of other fractions of municipal waste (paper, plastic, glass, etc.)
f) The amount of hazardous municipal waste (batteries, electric and electronic waste, etc.)

Article 13. Municipal Waste Collection and transportation Equipment

1. When planning waste collection and transportation system, a municipality shall consider specifications of collection vehicles and containers including reduction of time needed for unloading containers in the collection vehicles to ensure the efficiency of the collection process.
2. For optimized efficiency, municipalities shall, to the degree possible, standardize the equipment that they utilize for service provision including both vehicles and containers.
3. To the degree possible, municipalities shall purchase collection vehicles that are convenient for local conditions to increase the opportunity for procuring spare parts directly from local sources.
4. To the degree possible, collection containers should be procured from local sources (as referenced in Annex 1 of this Technical Regulation) to increase their immediate availability and decrease costs when replacements are necessary.
5. A municipality and a service provider shall ensure municipal waste collection without littering.

6. To ensure further recycling, in separate collection of combined, recyclable and recoverable materials of mixed municipal waste, a municipality shall use the standards stipulated by Articles 14 and 15 of the present Technical Regulation.

Article 14. Municipal Waste Collection Containers

1. Sufficient, properly designed and durable collection containers shall be provided to assure convenient service for all waste generators.
2. At a minimum, municipalities shall define its container requirements through analysis of the following criteria:
    a) Volumetric generation within the households and commercial premises that are expected to use deployed communal containers.
    b) Estimated number of people expected to use the individual container locations.
    c) Type and quantity of waste expected to be placed into a container.
    d) Longest expected time interval between container service.
    e) Expected seasonal variations of the quantity and physical characteristics of waste generated and delivered to the deployed containers.
    f) Location of the deployed containers and their distance to waste generators to be served. This distance is not to exceed 150-200m in the service area.
    g) Container size and capacity (including the need for multiple containers) based on the overall waste storage required at the specific point of collection as well as any limitations that may be created by collection vehicles and their loading mechanisms.
    h) Type of container including fabrication material, simplicity in terms of manual handling by waste collection personnel including the method of loading the accumulated waste into a collection vehicle. For this purpose, municipalities shall consider the utilization of large capacity containers as a communal container for domestic wastes, from markets, or from industrial and institutional sources which will also influence the collection process and the type of vehicles required for exchange of the containers.
    i) Durability where a standard container design is utilized that provides an optimum service life based on the rigors of the collection process.
    j) Loading method for allowing an efficient placement of the waste by generators and other persons.
    k) Method of isolating the waste including manageable lids and lid rings that will serve to isolate the waste from exposure and minimize potential odors that could occur as a result of biodegradable waste decomposition.

Article 15. Collection Vehicles

1. Municipalities and contracted service providers shall utilize collection vehicles that are compatible with the areas where waste is to be collected. To accomplish this, a municipality may utilize different vehicle designs for collection in specific municipal areas which have unique characteristics such as areas with narrow streets or roads with heavy traffic.
2. In procuring vehicles, municipalities shall consider the following criteria as further defined in Annex 1 of this Technical regulation:
    a) Waste collection service area physical conditions

b) Waste density
c) Waste constituents
d) Transport distance and road/traffic conditions
e) Loading heights and mechanisms
f) Type of vehicle
g) Locally available spare parts and availability of maintenance and repair;
h) Transitional factors

Article 16-Maintenance and Repair

1. Municipalities and contracted collection service providers shall utilize a formal and well defined preventative maintenance program (as described in Annex 1 of this Technical Regulation) to help assure the maximum effectiveness and service life of collection equipment.
2. Municipalities and contracted collection service providers shall develop a maintenance program that includes preventative maintenance activities and sufficient record keeping to closely monitor the function of all collection vehicles.

Article 17- Collection Staffing

1. Municipalities and contracted collection service providers shall establish the minimum number and qualifications of personnel utilized for the collection process based on the specific equipment that will be utilized, collection area, landscape, the frequency at which collection stops are serviced and other factors.
2. The municipality shall assure that sufficient personnel training and technical and managerial capacity is maintained for effective waste collection and transportation service delivery.

Article 18- Collection Routing Design

1. Municipalities shall assure that vehicle routing is designed and optimized for maximum efficiency and least cost.
2. Municipalities shall base their routing structures on the following parameters:
   a) Vehicle routes shall be designed to minimize the distance traveled for each collection made and maximize the loads collected;
   b) Traffic load in various areas of a municipality;
   c) Local legislation such as weight limits on roads and bridges to ensure safe waste transportation.

Article 19 - Transport and Transfer Stations

1. Municipal collection service providers shall design and operate their collection and transport systems to maximize the time that a collection vehicle is in the actual collection process while minimizing the time required to transport collected waste to receiving locations.
2. The need for transfer stations shall be determined by the municipality and Waste Management Code, in coordination with an authorized agency, based on the proximity treatment facilities and the possibility of cost reductions.

Article 20 - Prohibition and Control of littering

1. All collection and transport activities shall be undertaken in a manner to prevent littering or other environmental impact during collection and transport of all types of waste to transfer stations, treatment facilities and landfills.

2. Litter associated with the collection and transport of municipal waste shall be immediately cleaned up by the service provider and service adjustments must be made to prevent reoccurrence of litter, improve service quality and correct the deficiencies.

Article 21-Collection System Monitoring and Management

1. To optimize the performance of a collection system, municipalities or contracted service providers shall monitor the collection process and gather information to measure the productivity of the services provided.
2. Municipalities and contracted service providers shall monitor the following performance parameters to assure sustained system effectiveness in meeting the requirements of this Technical Regulation and the Waste Management Code:
    a) Data allowing the comparison of current performance with previous performance to indicate the effects of changes in collection system design, management approach or capacity building;
    b) Sufficient data for comparison of performance in different locations or municipalities;
    c) Data for monitoring the performance and activities of different collection crews (including driver assessment) in different collection routes;
    d) Data on the use of collection vehicles for scheduling preventative maintenance activities and to control the use of fuel;
    e) Data related to the performance assessment of different type of vehicles to guide future procurement efforts;
    f) Sufficient data for monitoring full collection costs based on the frequency of collection, the size of the crew with each vehicle, or the type or size of vehicle.
    g) Sufficient data to determine the time needed for collection and transportation.

Article 22 - Municipal Waste Treatment Requirements

1. Municipalities and other treatment service providers shall design and operate treatment processes and facilities to reduce the use of natural resources and to comply with the waste management hierarchy stipulated in Article 4 of the Waste Management Code.
2. When applying the waste management hierarchy, municipalities shall take all necessary measures to encourage the most environmentally sound, economically usable and available technology that will be the most effective in preventing, reducing or recycling negative impacts on the environment and human health.
3. In defining the treatment process to be utilized, municipalities and other treatment service providers shall base their decisions on the following factors:
    a) Availability of treatment equipment in Georgia or the region to assure sustained effectiveness as a result of readily available operational/maintenance supplies and spare parts sources;
    b) Demonstrated reliability to assure continuing treatment effectiveness;
    c) Design flexibility toaccommodate waste characteristic (composition, density, etc.) changes which could include the gradual implementation of separate collection for recoverable and recyclable materials;

d) Technical simplicity that allows sustained effective operational results with the minimum technical expertise and cost.

4. Municipalities and any other waste treatment providers shall ensure compliance of all treatment methods with requirements established by waste management legislation and this Technical Regulation.
5. In working to comply with the stipulated waste management hierarchy, municipalities shall take biodegradable waste management measures to encourage:

   a) The separate collection of biodegradable waste with a view to the composting and digestion of the biodegradable waste;
   b) The treatment of biodegradable waste in a manner that fulfills a high level of environmental and human health protection;
      c) The use of environmentally safe materials produced from biodegradable waste.

Article 23. Municipal waste treatment methods

1. Municipalities and any other waste treatment providers shall comply with treatment criteria presented Annex 2 of this Technical Regulation.

2. At a minimum, municipalities and other treatment service providers shall assure that the process (physical, thermal, chemical or biological) utilized for treatment of waste:

   a) Changes the characteristics of the waste;
   b) Reduces waste volume;
   c) Facilitates waste handling;
   d) Enhances waste recovery.

Article 24. Acceptable Alternatives for Waste Treatment

1. Municipalities and other treatment service providers shall ensure that acceptable treatment methods will be utilized to accomplish treatment requirements including:

   a) Source separation and separate collection of recyclable and recoverable materials
   b) Manual sorting of recoverable and recyclable materials
   c) Composting
   d) Mechanical treatment
   e) Biological stabilization of organic residues (after mechanical treatment)
   f) Thermal treatment
   g) Aerobic/anaerobic digestion.

3. At a minimum, municipalities and other treatment service providers shall assure that the process utilized for treatment of waste:

   e) Is a physical, thermal, chemical or biological process including sorting.
   f) Changes the characteristics of the waste; and
   g) Meets objectives that:
      1) reduce waste volume; or
      2) reduce waste hazardous nature; or
      3) facilitate waste handling; or
      4) enhance waste recovery.

Explanatory Note

To the Draft Resolution of the Government of Georgia On Approval of TECHNICAL REGULATION On MUNICIPAL WASTE COLLECTION AND TREATMENT RULE

Information on Draft Resolution of the Government of Georgia

Development of Draft Resolution of the Government of Georgia was defined by the following conditions:

The obligation of development of a Draft Resolution of the Government of Georgia on Approval of Technical Regulation on Municipal Waste Collection and Treatment Rule arises from sub-paragraph 1 of Paragraph 2 of Article 49 of the Waste Management Code of Georgia and is provided by the directive 2008/98 of Article 413 of the Agenda of Association of 2015.

Provisions of directive 2008/98 stipulated by Association Agreement were implemented by adoption of Waste Management Code.
The majority of EU member states regulates waste management by means of framework laws and ddetail-oriented Bylaws. This approach is reflected in Waste Management Code that sets legal frames related to waste management. As for the present Draft Resolution of the Government of Georgia, obligation to develop it derives from Paragraph 5 of Article 16 of Waste Management Code of Georgia.

Applicable directive 2008/98 (adoption of national legislation and definition of competent agensies) was implemented under Paragraph 8 of Article 6 of Waste Management Code where municipal waste management is a competency of municipalities. Exceptions are non-hazardous waste landfills and Paragraph 3 of Article 16 according to which municipal waste generator other than local residents is authorized not to use the municipal waste collection service and transfer the municipal waste that he/she generated for collection and treatment to the person who, according to the Code has the right to collect and treat waste. Registrations and permits related to waste management are provided by Chapter VII of the Code.

Implementation of an applicable provision of Directive 2008/98 – Introduction of Registration of Waste Collection and Transportation Agencies and Enterprises (Chapter IV) was conducted under Article 26 of Waste Management Code. Besides, registered persons implementing activities related to municipal waste management possessing permits are governed by Article 7 of Draft Resolution of the Government of Georgia.

Applicable provision of Directive 2008/98 – development of waste management plans according to a 5-step waste hierarchy and development of waste prevention programs (Chapter V, excluding Article 29(4) is integrated into Chapter III of Waste Management Code that deals with waste management planning on a national level by development and approval of municipal waste management plans by municipalities.

Moreover, Chapter IV (Article 16) of the Code provides municipal waste management, namely, municipalities must provide development and functioning of an efficient waste collection system. Also, municipalities shall develop municipal waste management plans. The obligation to introduce a separate waste management system will be become effective on February 1, 2019. The requirements related to municipal waste management plans are provided by Articles 5 and 6 of Resolution of the Government of Georgia.

Applicable Directive 2008/98 – Development of a Cost Recovery Tool based on the Polluter Pays principle (Article 14) is integrated in Subparagraph “b” of Paragraph 2 of Article 5 of Waste Management Code. The above issue is provided by Article 4 of the Draft – Application of Waste Management Principles.
The goal of the Resolution of the Government of Georgia is to contribute to development and proper functioning of the effective municipal waste collection and treatment system for which it sets requirements and criteria related to municipal waste collection and treatment.
The project considers various methods and alternative approaches to waste collection service provision, including the types of waste collection vehicles and containers, factors to be considered in their selection, issues related to identification of equipment and personnel required for waste collection, definition of optimal frequency and timetable of waste collection, separate waste programs development and implementation, factors related to technical service, management of waste of special qualities, emergency response procedures in extraordinary and special cases, minimum waste treatment requirements, description of technical options, methods and alternatives of recovery and treatment.

Expected results of the Draft Resolution of the Government of Georgia

Requirements related to municipal waste collection and treatment will be established by the adoption of Draft Resolution of the Government of Georgia.

Calculation of financial and economic outcomes caused by the adoption of the Draft Resolution of the Government of Georgia

The adoption of the Draft Resolution of the Government of Georgia will not result in allocation of additional funds from the state budget. In addition, development of the appropriate municipal waste collection and treatment system and infrastructure in accordance with the requirements of the present Technical Regulation will be related to certain expenses.

Terms of implementation of the Draft Resolution of the Government of Georgia

The terms of implementation of the Draft Resolution of the Government of Georgia are not defined.

Author and presenter of the Draft Resolution of the Government of Georgia

The author and presenter of the Draft Resolution of the Government of Georgia is the Ministry of Environment and Natural Resources Protection of Georgia.

Annex 1

Municipal Waste Collection and Transfer Guideline

1. Alternative Waste Collection and Transfer Technologies and Configurations

1. The following factors have a direct bearing on the collection system configuration choices that are available to Georgian municipalities:**Waste generation rate** - The amount of waste has a significant impact on thecollection system and its technical alternatives (including principal decisions related to the type and number of vehicles and containers that are required in any municipality). The average waste generation rate in Georgia is within the range of 0.3 to 0.5 kilograms per capitaper day. This can define the amount of solid waste generated by a municipality's entire population. This waste generation rate can also be utilized to estimate the amount of solid waste that must be collected in various zones of a municipality.
2. **Waste density** - The density of waste to be collected varies depending on the affluence of acommunity and the way in which waste is handled and stored. The waste in many countries such as Georgia is naturally dense (ranging between 300 to 500 kg/m^3) due to high organic content. Typical compactor trucks aredesigned to compact light refuse to about a density of 100 to 400 kg/m^3. Therefore, countries with emerging economies may require little or no compaction for cost effective transport. This may reduce the value of technicallycomplex collection vehicles or compactor-based transfer stations when compared to their applicability in industrialized regions such as the E.U. (However, compactor type vehicles can have a significant benefit byrelocating the waste placed into a collection vehicle thereby facilitating collection efficiency.)
3. **Transport conditions -** Road conditions, traffic density and transport distances to processing or disposal facilities (which are unique to each municipality in Georgia) have a significantinfluence on collection and transfer vehicle choices since they influence the amount of time that it takes to transport collected waste to the treatment or disposal locations. (The creation of regional landfills throughout Georgia will have an important effect on existing collection programs in some municipalities by significantly increasing transport distances beyond what was previously required to deliver collected waste to local dump locations. This additional transport time may justify the need for transfer stations to help reduce transport costs.)

There are four basic approaches available to Georgian municipalities to accomplishsolid waste collection, including:

1. Communal collection,
2. Curbside/alley collection,

3. Block collection (also referred to as just-in-time collection), and
4. Door-to-door collection.

In communal collection (which is the method primarily used in Georgia), a public location is designated as a communal collection point through the placement of a container or number of containers that are shared by the nearby community for waste placement purposes. In block collection, a collection vehicle stops at a convenient place at a designated time and generators deliver their waste to the vehicle. In curbside collection, waste generators place their individual waste containers at the side of the road that they retrieve later after collection is completed. In door-to-door collection, a collector crew member actually enters the premises for collection of the waste "at the door".

As would be expected, the choice of a collection approach influences the convenience of the collection system for waste generators. However, as is the case with many things, increased convenience usually translates into increased cost. Key aspects of the various collection approaches follow:

Communal Collection- One crucial aspect of using a communal collection approach is the decisions as to what kind of containers are deployed and where these containers are placed. Container locations can consist of street corners, several locations on densely populated roadways or at the edge of neighborhoods or villages accessible to both generators and collection vehicles. One of the main advantages of communal collection points is that they allow a household to have continual access to a collection point.

Sound practice in communal collection design requires that solid waste managers understand the potential conflict that exists between the need to accomplish public convenience and the need to maintain cleanliness and sanitary conditions at and around all communal container locations. If a communal collection point receives ineffective service attention, containers may overflow and cause aesthetic or health related problems such as odors and insects in the vicinity of the container location.

Sound practice associated with this collection approach requires that there are an adequate number of containers distributed atappropriately located collection points that do not require waste generator to carry their waste more than 150 to 200 meters from their residence to a container location. To be effective, containers must be easy to use even for children who are often called upon by their parents to bring the waste to communal containers. Sound practice also requires frequent container service and immediate cleanup of overflows as they occur for whatever reason. Basic advantages and disadvantages to the communal collection approach include following:

Advantages:

- Drop-off in a communal container is the least expensive of the common collection approaches.
- This method involves lower collection staffing requirements that the other methods.
- Waste containers are always available for waste delivery by generators.
- Georgian municipalities are already experienced in managing systems with this collection approach.

Disadvantages:

- Residents are inconvenienced by having to bring their waste to the collection point.

- There is an increased risk of injury to residents.
- Illegal dumping/scavenging may occur leading to waste accumulation outside of and near to the container.

The criteria for deciding the type of container to utilize in a municipality is shown in the following box:

KEY FACTORS IN PROCURING CONTAINERS

- Choose containers made of local, recycled, or readily available materials. Sometimes designing an attractive and uniform container can significantly alter public waste practices and effect a change in behavior.
- Standardization of containers can have a significant benefit both from an economic and performance basis. If possible, standard container design and local availability will help assure that replacement containers are readily available if required
- Choose containers that are easy to identify, due to either shape, color or special markings. There is some advantage to specifying a set of uniform containers when introducing a new collection system, as this communicates the official nature of the collection and adds to perception of importance. Also, if the container is easily recognizable, it may act as some deterrent to theft.
- Choose containers that are sturdy and/or easy to repair or replace. This is essential to the sustainability of a collection system over the long term in terms of system reliability and cost control. It is also essential to ensuring that the containers are not blown over by wind, or readily disturbed, toppled over by waste pickers or scavenging animals.
- Chose containers that do not prevent access by waste pickers: if waste pickers find it difficult to access a container, they may be tempted to overturn it and allow waste to be strewn across the street, thereby defeating the purpose of the container.
- Choose containers that are appropriate to the terrain: on wheels where there are regular paved streets; waterproof where it rains a lot; heavy where there are strong winds, etc.

Curbside Collection– Many collection systems in developed countries depend on regularly scheduled set out of individual container for curbside or alley collection of waste. In these collection systems, the collection agency specifies the size and type of containers to be used by waste generators served by the collection system. The aim of the container specification is to standardize general container characteristics for handling by collection crews. Suitable individual storage containers must be easy to handle and keep clean and should be designed to limit the potential for the spread of disease and keep out animals and insects. Containers should be large enough to limit the number of containers at a stop while small enough to be lifted easily and safely by one person or to be compatible to a collection vehicle mechanized system for unloading the containers.

In many countries that utilize this form of collection, two types of containers commonly used are including 1) metal or plastic bins and 2) paper or plastic bags. In developing countries or rural areas, set out containers for this type of collection may include bags, pots, plastic or paper bags, cane or reed baskets, boxes, clay jars or any other kind of container to store solid waste and make it available for collection.

Advantages and disadvantages of the curbside approach include the following:

Advantages:

- Collection crew can move quickly from one collection stop to another,
- Collection crew does not enter private property,
- This method is less costly than backyard collection because it generally requires less time and fewer collection personnel to access the waste to be collected, and
- The approach is adaptable to automated and semi-automated collection equipment to reduce staffing requirements.

Disadvantages:

- On collection days, waste containers are visible on the street,
- Collection days must follow a consistent and reliable schedule,
- Residents are responsible for placing containers at the proper collection point at the correct time, and
- The cost of this level of service may be prohibitively high in areas with limited resources due to increased staff requirements when compared to the communal container approach.

Block collection - In method of collection, a collection vehicle travels a predetermined route at prescribedintervals, usually every two to three days, and stops at selected locations where an indication of the trucks arrival (a bell is sounded, for example) takes place. Alternatively, the collection vehicle may play music as it drives along the roadways near the collection point to notify waste generators of its arrival. Upon hearing the designated signal, waste generators bring their waste to the truck location where the crew will place it into the collection truck. In some cases, the waste generators will directly load the waste into the vehicle. No containers are left in public places. Vehicle and labour productivity of this system lies between lowand medium. The timing must be such that there are residents or servants in the properties to bring out their waste, otherwise the waste will be left out in the street.

Advantages and disadvantages of the block collection approach include the following:

Advantages:

- Collection crews only have to address one location in each community,
- Collection crew does not enter private property.
- No containers are left in public places

Disadvantages:

- On collection days, somebody must be at home to bring waste to the truck location,
- Collection days must follow a consistent and reliable schedule,

Door To Door Collection– This collection approach requires waste generators to do no more than to store their waste outside their back doors. At collection time, the collection crew enters each property, takes out the waste container, empties it into the collection vehicle and returns the containerto its place outside the door. The lack of waste generator involvement in the collection process results in increased laborcosts due to the time that it takes to enter the generator premises twice for each collection stop. Where labor costs are high, this method of collection may be twice as expensiveas curbside collection. Because of its overall cost and the need to enter private property, this method of collection is rarely used.

Collection from Apartment Buildings– There are also options for collecting waste from multi-story apartment buildings.The first approach provides waste storage outside of the building or in a designated location on the building ground floor from which the waste can be collected by the collection crew. Wastes may be brought to these containers by the residents themselves, by the staff of the building or by means of vertical refuse chutes that have openings on each floor so that residents can put their waste into the chutes so that it drops into containers at ground floor level. (While found in many older multi-story buildings, such chutes have proved problematic due to blockage, odors, or insects.) Another alternative for collecting waste from multi-story buildings requires collection crews to collect waste from each apartment with waste left outside each door or with crews knockingon the doors to ask the residents to provide their waste. This is clearly very labor-intensive and is also rarely used.

2.5 Factors Affecting Collection Vehicle Decisions

The collection process consists of a collector or collection crews that travel through a collection service area with or without a vehicle for collecting the waste materials from generators. Collection vehicles used in any municipality must be appropriate to the terrain in which they must travel, the population density of the waste generation service areas, the roads over which the vehicle must travel, the type and quantity of waste to be collected, the strength and work habits of the collection crew, and the distance to the processing or disposal location where the waste must be delivered after collection. Because of the varying conditions in Georgian municipalities, a mix of vehicle types and sizes may be required to collect waste from all areas within a municipality. For example, vehicles utilized in urban core areas may vary significantly from the type of vehicles that are required to service areas in municipalities that have narrow roadways.

Collection Vehicle Types - Collection vehicles can range from musclepowered carts and wagons (often used by micro-businesses to provide collection from communities and remote limited access villages to larger containers that may be placed in the vicinity of a remote village area) to technically complex waste compactor vehicles.

Municipalities must choose collection vehicles that are best suited to the characteristics of the collection service area and the method of collection utilized. The issues that can affect vehicle selection within any municipality include: 1) anticipated service levels (frequency of collection, etc.), 2) collection crew size (and the resulting cost of labor), 3) collection route characteristics and 4) budgetary constraints. The above may influence whether a municipality chooses to use compactor or non-compactor vehicles.

Non-Compactor Vehicles - Conventional dump trucks can be used in collection and have the advantage of being adaptable and readily available in most countries. Repair and maintenance of this type of vehicle is less specialized (and therefore less costly) than that for collection vehicles designed solely for the purpose of collecting and compacting solid waste.

Some of the advantages and disadvantages ofutilizing non-compactorcollection vehicles include the following:

Advantages:

1. Efficient when waste is generally wet or dense
2. Practical where labor is inexpensive
3. Practical where there is limited access to skilled maintenance for more complex vehicles
4. Collection routes are long and relatively sparsely populated
5. Trucks are potentially universally available from local or regional sources
6. Trucks are flexible and can perform a number of different collection or other tasks.

Disadvantages:

1. Waste loads often have to be covered while transporting waste to transfer, processing or disposal points so as to prevent the deposition of waste from the trucks onto roads,
2. Some non-compactor trucksoften do not have an automaticmeans for offloading solidwaste thereby requiring an extensive amount of time and effort to offload,
3. Many government officials believe that a modern efficient collection program must include compaction vehicles and that non-compactor vehicles represent lower efficiency,
4. Donor agencies tend to recommend equipment used in their own countries and they tend to assume that compactor trucks represent the best use of their donated money.

Compactor Vehicles - Waste compaction vehicles are normally classified by their loading characteristics and as either rear-loading or side-loading.

- **Rear Loaded Trucks** - Rear load trucks are best suited to areas that have a high population and where there are frequent and numerous collection stops. This loading configuration allows both sides of a roadway or alley to be collected at the same time in a curbside collection program. Sideloaded vehicles are best suited to densely populated areas where collection takes place in only one side of a road or for rural routes. There are a number of U.S. and E.U. companies that manufacture rear-loading collection vehicles that are available in the number of different body sizes ranging from about 7 to 25 cubic meters in payload capacity. Generally, the design of solid waste compactors is intended to provide increased waste compaction to increase the amount of waste that can be loaded into a vehicle thereby minimizing the number of times that a waste collection vehicle will have to travel to a transfer station or disposal location to offload. Rear load bodies have several advantages when compared to side loaded trucks. Typically, the hopper in a rear loaded vehicle is lower than that for a side loaded truck. As a result, the collection crew does not have to lift containers as high to gain access to the truck hopper. In addition, rear loading vehicles can be equipped with mechanisms to assist in emptying large communal containers that are compatible with the truck loading mechanism. One disadvantage, however, is the general complexity of the rear loading mechanism with its accompanying higher maintenance requirements.Rear load vehicles are emptied either by gravity or through use of an ejection system. Gravity offloading is accomplished by tilting the container section of the vehicle so that the load slides out in a manner similar to the function of a conventional dump trucks.

- **Side Load Trucks** - Side loaded vehicles are best suited to densely populated areas where collection takes place in only one side of the street or for rural routes. Size ranges of these trucks range from5 to 30 cubic meters in payload capacity. Compaction density associated with side loaders is generally slightly lower than that for rear loaded equipment.

Compactor type trucks are thestandard of sound practice in most developed countries where their cost can be afforded. Generally, compactor type trucks are designed specifically for the purpose of collecting solid waste. Advantages and disadvantages of compactor type vehicles include the following:

Advantages:

1. Allow waste to be placed into the vehicle from either the rear or side of the vehicle.
2. Compacts the waste to a higher density using either hydraulic or mechanical pressure thereby increasing the amount of waste that can be placed in a truck prior to transport
3. Compatible with standard container designs to allow mechanized collection from containers,
4. Hides the waste from the public after collection thereby adding to the “invisibility” of the collection system.
5. Prevents vectors from reaching the waste after it has been placed into a compactor truck.

Disadvantages:

1. High capital and maintenance cost
2. They are designed for a limited purpose with little flexibility for alternative use.
3. Significant amount of mechanical mechanisms that require specialized maintenance
4. High fuel usage with the resulting high operating costs,
5. Requires paved streets wide enough to allow passage and turning during collection,
6. The waste must be set out in containers or bags so that the collection crew can to pick them up or specialized containers need to be used for the communal collection location to allow mechanized collection.

Specialized Commercial Collection Vehicles –Solid waste must also be collected from commercial establishments and industries as well as residences. Many small businesses in a municipality will utilize the communal containers for their waste. In some cases, however, commercial or industrial waste may be collected by private contractors or under a contractual relationship with the municipality for direct collection. Typically,commercial waste differs in both quantity and composition from residential waste and is often stored in large containers at the generation locations for eventual collection. Rear loading and side loading trucks are often used for managing these containers. Also, front loading, and container drop-off mechanized truck configurations are also used. Front loading equipment is designed for use with specifically designed containers. The container is picked up by hydraulic arms, lifted over the truck cab, and contained waste is discharged into a hopper in the top of the rear compaction body.

Trucks that are equipped to handle large drop-off containers are also frequently used for the collecting industrial and commercial waste. In these cases, the collection containers are physically picked up, transported to a disposal or processing location, emptied, and returned to the premises on the same truck. In some cases, an empty container is dropped off at the time that a full container is retrieved thereby providing continual access to a waste container by the generator. Two types of vehicles are utilized for this type of collection. A dumpster type allows a container to be lifted onto a truck by hydraulically actuated arms attached near the rear of the chassis. The other type uses a tilting frame chassis that moves bins on and off the chassis by means of a chain or cable.

Criteria for Equipment Selection

Collection equipment has to be appropriate for the specific conditions that a municipality must accommodate in providing its collection service. To determine equipment requirements, municipal officials responsible for procuring collection vehicles must clearly understand those conditions and develop requirements for the vehicles to be procured. Equipment suppliers should then be contacted to provide equipment specifications for the trucks and chassis that they can provide to determine that they are appropriate for the municipal requirements.Below are given the general criteria that should be used to determine the most appropriate collection equipment for any specific use.

KEY FACTORS IN PROCURING COLLECTION VEHICLES

- Choose locally made equipment based on traditional vehicle design whenever possible, supplemented by assistance from waste collection managers and specialists who may currently be involved in providing waste collection services. If there are no applicable local or regional sources of required vehicles, select equipment that is appropriate for the collection service to be provided.
- Select equipment that can be locally serviced and repaired, and for which parts are available locally or regionally.
- Consider a wide range of vehicle types and evaluate each carefully for the specific applications required in the collection system service area.
- Select vehicles that deliver based on documented and objective performance evaluations performance in an objective manner. If possible, check with previous customers on operation and maintenance performance, including spare parts delivery.
- Allow for downtime when planning collection system fleet requirements. Purchase sufficient vehicles to ensure that downtime periods can be covered by stand-by vehicles. A reliable principal is that technically complex equipment may experience more downtime than simple design.
- Choose muscle powered or light mechanical vehicles in crowded or hilly areas or high-density settlements where conventional truck access is limited or non-existent.
- Choose non-compactor trucks, wagons, dump trucks or vans where population is dispersed, or where waste is already in a dense condition. These trucks are often lighter, more fuel efficient, and easier to maintain. Where waste is already dense, compactors may offer few benefits
- Consider the advantages of hybrid systems where appropriate: satellite manual, electric or propane powered small vehicles feeding a larger slow-moving or stationary compactor truck or containers. The appropriate collection vehicles for old city center, modern commercial center, affluent suburban areas and poor neighborhoods may vary significantly.
- Non-compactor trucks generally offer lower capital and operating costs in return for higher labor requirements. In developing countries, this may be an advantage.

Municipalities can use the above criteria to define the general equipment types that will be needed for their municipality. It is likely that the vehicles that can meet the municipality's required specification for waste collection can be provided from a number of regional suppliers thereby providing alternative sources for required vehicles with the accompanying economic benefits that may be associated competitive bidding.

Other factors to consider in determining type of collection vehicles that are required the specific conditions within any municipality include the following:

Truck Body Capacity - Compactor capacities can range from 10 to 45 cubic yards.To select the best capacity of collection vehicles for any particular municipality, the best tradeoff between labor and equipment costs should be determined. Larger capacity bodies may have higher capital, operating, and maintenance costs but can decrease the cost of collection by improving the unit collection efficiency. However, heavier trucks may increase wear and tear (and corresponding maintenance costs) for roads. Design factors related to truck body and container capacity include the following:

- The loading speed of the crew and collection method used.
- Road width and regulated weight limits (consider weight of both waste and vehicle).
- Required truck capacity should relate to the quantity of wastes collected on each route factoring in the number of times that a collection vehicle must travel to a processing or disposal location for offloading.
- Travel time to a transfer station or processing/disposal site, and the probable life of that facility.
- Relative costs of labor and capital.

Chassis Selection - Chassis are similar for all collection bodies and materials collected. Design and construction factors related to chassis selection include the following:

- Size of truck body. (It is important that the truck chassis is large enough to hold the required truck body filled with solid waste.)
- Road width and weight limitations (considering both the waste and truck weight).
- Vehicle related air emissions control regulations that may be in effect.
- Desired design features to address harsh local conditions and collection requirements (e.g., driving slowly, frequent starting and stopping, heavy traffic and heavy loads) This could include: high torque engines, balanced weight distribution designs, good brakes, good visibility, heavy duty transmission, and power brakes and steering.

Loading Height - The lower the loading height, the more easily solid waste can be loaded into the truck by a collection crew. If the truck loading height is too high, the time required for loading and the potential of injuries to crew members will increase because of strain and fatigue that may be caused. Design construction related to loading height include the following:

- Weight of full solid waste containers.
- If higher loading height is being considered, an automatic loading mechanism should be utilized.

Loading and Unloading Mechanisms - Loading mechanisms should be considered for commercial and industrial applications, and for residential applications when municipalities wish to minimize labor costs over capital costs or when communal containers are utilized. A variety of standard unloading mechanisms are available. Design criteria related to loading and unloading mechanisms include the following:

Loading:

- Labor costs of collection crew.
- Time required for loading at individual collection stops.
- Interference from overhead obstructions such as telephone and power lines.
- Weight of waste containers.

Unloading:

- Height of truck in unloading position.
- Reliability and maintenance requirements of hydraulic unloading system devices.

Truck Turning Radius–The turningradius of selected vehicles should be as short as possible, especially when part of the collection route includes blind alleys. Short wheelbase chassis are available when tight turning areas will be encountered in some situations within a municipality's collection service area.

Watertightness - Truck bodies must be watertight so that liquids seeping from collected waste does not escape.

Safety and Comfort - Vehicles should be designed to minimize the danger to waste collection crews. Design criteria related to truck safety and comfort include the following:

- Carefully designed safety devices associated with vehicle compactor mechanismsshould include quick-stop buttons. In addition, the mechanisms should be easy to operate and convenient.
- Truck should have platforms and good handholds so that crew members can ride safely on the vehicle from collection stop to stop.
- Cabs should have room for crew members and their belongings.
- Racks for tools and other equipment should be supplied on the vehicle.
- Safety equipment requirements should be met (including the available of personal protection equipment).
- Trucks should include audible back-up warning device for the protection of collection crews or others that may be in proximity to the vehicles.
- Larger trucks with impeded back view should have video cameras and cab-mounted monitor screens for driver assistance in.

Speed - Vehicles should perform well at a wide range of speeds. Design criteria related to truck speed capabilities include the following:

- Distance to disposal site.
- Population and traffic density of the collection service area.
- Road conditions and speed limits of routes that will be used both during collection and during transport to a transfer station or processing/disposal location.

The above vehicle requirements can likely be met by numerous suppliers with equipment that may have been utilized extensively in municipalities similar to those in Georgia.

3. DESIGNING AND IMPLEMENTING AN EFFECTIVE COLLECTION SYSTEM

Characterize the Existing Collection System

The starting point for any program aimed at achieving effective waste collection in a municipality is an assessment of current collection practices and conditions. It is important that both the physical aspects (containers, vehicles, transfer points, transfer stations, etc.) and the functional issues (staffing, scheduling, route structures, fee systems, legal/political framework, etc.) be evaluated to determine that they are appropriate to the required setting in which an improved collection and transport system will function.The following are a number of the key factors to beevaluated prior to deciding what collection modifications are necessary in any municipality to improve or expand collection services.

1. **Estimate the quantity and composition of solid waste in the collection service area -** While thequantity and composition of solid waste generated in a municipality is important in the design of disposal facilities, the designof a collection and transport

system must evaluate the amount of solid waste generated in theindividual segments of the municipality'scollection service area within a municipality or in the service areas served by individualcommunal container collection points.The prevailing Georgian collection model where communal containers are commonly utilized must be capable of managing various waste forms including:

- **Household waste** – consisting of organic kitchen waste, household sweepings, rags, paper and cardboard, and a small but increasing percentage of plastic and a small proportion of other materials such as glass, rubber, leather, bones, and metals.
- **Commercial waste** – including waste from markets, shops, offices, restaurants, warehouses and hotels (While large scale commercial enterprises may provide their own collection and transport services, small commercial waste producers will often use the municipal collection system communal containers for waste management purposes.)
- **Institutional waste** – including waste from schools, governmental offices, hospitals, and religious buildings. While institutional wastes may consist primarily of paper, it may also have some of the same characteristics as residential waste if the served institutions contain residential accommodations.
- **Street sweepings** – normally consisting of sand, stones, and debris from traffic accidents as well as paper and plastic litter dropped by pedestrians or from vehicles.
- **Drain wastes** – derived from cleaning open storm drains and culverts near communal containers.
- **Foliage and garden waste** – including residues of gardening and pruning.
- **Small scale industrial waste** – derived from small scale and cottage industries that utilize communal containers

Effective design of any collection system must consider the sources of any of the above waste streams both from a waste quality and quantity standpoint to verify that sufficient resources are applied to provide effective collection services. In seeking to design an effective collection system or to optimize current programs, a municipality should utilize the experience gained in historically operating its waste collection system. For example, the amount of waste generated in any specific locale within a municipality can determine the collection assets (containers, trucks, etc.) that are required for providing an effective collection process within other specific locales with the same general land use characteristics. In addition, Municipalities must consider the nature of the waste to be collected in any location since the physical characteristics (such as compacted and uncompacted density) of the collected material will influence the selection and operation of collection vehicles.Municipalities should generate the following information in making any design or service optimization decisions concerning waste collection and transfer systems:

- The average weight of waste produced each day per capita or per household (generation rate) in the area to be serviced and population data to develop an estimate of the weight of waste to be collected each day.
- The average density of the waste after loading into a collection vehicle. This, combined with the generation rate, will determine the volume of waste to be collected each day and whether compacted trucks or non-compacted vehicles are more appropriate for use.
- The presence of significant quantities of biodegradable organic wastes that will influence the maximum length of time between collections so as to avoid insect problems, odors and corrosion problems in containers and vehicles as organic waste decomposes to form acids.
- The inert content of the waste (sand, clay, etc.) to determine whether there will be problems with abrasive wear in compaction type vehicles.
- If there are significant quantities of other types of waste in the area to being considered, such as market waste or office waste, the municipality must estimate the density and quantities of these wastes to assure sufficient collection capacity.

2. **Define the physical characteristics of collection service areas -** The physical characteristics (topography, road networks and conditions, access to collection points, etc.) of the collection service area can have a major impact on system design. The accessibility of roads within thecollection area is crucial in determining the types of vehicles that can be used in the collection program. Transportation patterns within a service area will also determine which roads will be difficult to use during peak traffic periods thereby affecting the process by which collection occurs on a regular basis. The physical characteristics of the service area will be important in defining the type and number of trucks. This may lead to a mix of trucks to address all conditions that will be experienced.
3. **Develop an asset inventory –**Municipal collection and transport system planners should develop an asset inventory for theirexistingsystem. This inventory should include all physical assets (trucks, containers, etc.) andpersonnel dedicated to the collection and transport process. It should also include any temporary assetsperiodicallyapplied and available to the collection system. If communal containers are used, their number and locationof the deployed containers should be shown on a collection system map that defines the extent of container placement and areas served.
4. **Define existing collection routes -** If curbside or communal collection is utilized, an existing route mapshould be developed to show the extent and configuration of the collection route travel structure including the roads covered and the direction of travel on these roadways
5. **Determine the effectiveness of the existing collection system -** An efficient collection system collects as much waste as possible with a given amount of labor and capital in as short a periodas possible. The effectiveness of the existing collection system can be evaluated in a number ofways. If the system utilizes a communal container collection process, the accumulation of solid waste outside of collection containers may be an indication that the containers are not serviced frequently

enough or that there are an insufficient number of containers at a particular location. Crew productivity is an important measure of collection efficiency. The factors that define and influence crew productivity include route structure, service level, type and number of collection equipment and the personalwork characteristics of the crew members. (This can include whether the collection crew pays too much attention to the process of recovering materials that they can sell as they go through the collection process.) The type and condition of collection vehicles can affect crew productivity through loading location, loading height, vehicle capacity, compaction density, and the age/condition of the truck. The individual crew member factors that can affect productivityinclude age, attitudes toward their work, and health/safety issues. The basic means by which crew productivity can be measured is by simply observing the collection process to determine a practical level of performance that should be expected from collection crews on a regular and measurable basis. Initial and periodic time study observations may be required to determine how a collection crew spends its time inperforming its duties.

6. **Identify collection system deficiencies –** Because of the visibility of collection services, system deficiencies can be determined by the extent of waste accumulation outside of the collection containers. Complaints are another gauge of system performance and deficiencies. The extent of collection vehicle breakdowns and their impact on the reliability and level of service can also be an indication of system deficiencies.
7. **Identify actual collection costs through full cost accounting –** Proper design requires thatmunicipalitiesclearly understand the total costs associated with their collection service and the impact that system performance can have on those costs. In collection, total costs must include all cost components for full time and temporary equipmentand personnel. By aproper analysis of full costs of the current collection system, the savings thatcan be realized through improvements in collection efficiency and the service fees that need tobe charged to cover costs can be calculated. This is particularly important because of the polluter pays principle stipulated in the Georgia Waste Management Code.

5. Determine Required Collection Equipment

In its most simplistic form, collection consists of a collector or collection crew that moves through a collection service area with or without a vehicle tocollect waste materials from generators or from communal containers. Vehicles used in this process may range from smalland simple vehicles to large complex automatic compaction trucks such as those used in many cities in developed countries for curbside collection.

The spacing by which community storage or communal containers should be located depends on the extent to which the community is willing to cooperate in their proper use by carrying their waste to container locations rather than dropping the waste in the street or open plots near their homes and businesses. Typically, communal containers should be placed that the distance between any two containers does not exceed 200 meters. In congested areas especially it may not be possible to locate containers within those distances.

5.Determine Required Collection Personnel

One basic factor in determining the cost and efficiency of municipal collection and transport programs is thesize, capability, and motivation of the collection crew assigned to the process of physically collecting the solid waste from waste generators. The optimum crew size depends on labor and equipment costs, collection methods (curbside, communal containers, etc.) and routecharacteristics. These need to be determined based on the actual characteristics of each municipality and its individual service areas and collection routes.

6. Determine Effective Collection Routes

Collection Service Areas - The collection service area is an area that falls within the jurisdictionof a municipality or private company providing the collection service and is often defined by political or geographicalboundaries. For definition of the technical aspects of a collection system, these limits as well aslocation of and routes to transfer stations, processing and disposal sites should beshown on an overall service area map that will be used for a number of planning and design purposes. Dividing a service area into zones for daily collection (if less that daily collection frequency is utilized) sets up collection zones. A municipality may have zones that are collected daily or more frequently as well as zones where collection occurs less frequently. So as to balance the collection system and to maintain high productivity, the average number of households assigned to each collection zone should be approximately equal with some consideration of the unique characteristics of each zone.

Each zone may be divided into an optimum daily workload for each collection vehicle and crew. This subdivision should be aimed at assuring that communal containers are serviced on aprogrammed and consistent basis in a manner that assures their effectiveness. The definition of collection zones allows the agency responsible for the collection service to 1) estimate the number and size of trucks needed to collect waste in any particular area, 2) evaluate crew performance on an ongoing basis and 3) balance or equalize the workloads between the collection zones.

Major considerations in the development of the balanced collection zones are the productivity of the crew and the on-route time. Increases in either of these factors will lower the costs associated with collection. On-route time is productive time and should be maximized to allow thecollection crew to collect as many stops (or communal containers) as possible on a givenworkday. Generally, the major variable in on-route time is the time actually spent in travel to and from a processing or disposal location once a truck is filled.

Collection Routes - Within a collection zone, collection is usually structured into specific truck routes. A route is thepath followed by a single collection vehicle for waste collection on a single day. The objective ofrouting is to direct the collection vehicle through the collection zone so that wasted time is kept at aminimum. Routing can be applied to trucks and crews performing curbside collection as well as to those that are servicing communal containers.

In routing analysis, maps should be prepared showing the number and type of collection stops per road segment or the number and location of communal containers. Where curbside collection is utilized, the map should also reflect roadways with specific characteristics such as dead-end streets or particularly busy streets. Each road segment should show truck direction by arrow and whether one or both sides of the road can be collected on a pass.

Routes can be set by a number of different methods including 1) trial anderror, 2) computer analysis, or 3) heuristic methods. The heuristic approach consists of applying experience, common sense and certain rules of thumb (or "heuristics") to develop anacceptable,but not necessarily best, solution to solid waste collection routing. Heuristic routing wasdeveloped by the United States Environmental Protection Agency in the mid-1970's as acompromise between trial and error and computer approaches. While heuristic routing is moreprecise than trial and error methods, it requires less preparation time and technical resources than is required forcomputer analysis. The heuristic method of designing collection routes is a good tool for municipalitiesto analyze curbside collection. The heuristic method uses specific routingguidelines including the following:

1. Routes should not be fragmented or overlapping. Each route should be compact consisting ofroad segments clustered in the same geographical area.
2. Collection plus haul time should be reasonably constant for each route.
3. The collection routes should begin as near the garage or truck point of origin as possible.
4. Within the route, right hand turns are preferred to left-hand turns because of their greater efficiency.
5. Heavily travel roads should not be collected during rush hours.
6. One-way roads are best collected by starting near the upper end of a road working downthrough a looping process.
7. Dead-end roadways should be considered as a segment of the roads they intersect. They must becollected by driving down, backing down or making a u-turn. Left turns may be kept to aminimum by collecting dead-end roads when they are to the right of the truck.
8. Steep hills should be collected on both sides of the road while the truck is moving downhill for safety, loading ease, collection speed, vehicle wear, and fuel conservation.
9. Higher elevations should be at the start of a route.
10. For collection from one side of the road at the time, it is generally best to route with clockwise right turns around blocks.
11. For collection from both sides of a road at the same time, it is generally better to route with long, street paths along the grid.
12. For certain block configurations within a route, specific routing patterns should be applied.

This type of analysis forms the basis by which municipalities can continually review their route structures to determine what improvements to a level of service or cost savings can be accomplished by periodic modifications. A new analysis and change in configuration (rerouting) of collection routes should be considered whenever there is a significant change in the collectionsystem which could include a change in:

1. Frequency of collection;
2. Type of collection points (communal container,curbside, etc.);

3. Crew size;
4. Truck size or type;
5. Location of processing and disposal sites;
6. Type of containers used; or
7. Number of service stops.

7. Determine Optimum Collection Frequency And Schedules

The frequency at which solid waste is collected is an important factor in defining collection cost and efficiency. In most industrialized countries, collection occurs once or, at most, twice per week. One advantage of communal containers is that generators can bring their waste to the container at any time. As a result, household storage as would be required if curbside collection occurred a frequency less than once per day does not become a problem. However, a problem can occur if the collection schedule for the communal containers is not sufficient to keep them available for waste placement because they are full. Sound practice in collection frequency must include an analysis of the needs and desires of the municipality, the health risks associated with less frequent collection, the importance of nuisance issues such as odor and, finally, the necessity of scheduling collection at times when the roads are not too crowded to impede the collection process.

8. Evaluate the Effect of Transfer on the Cost and Efficiency of Collection

All waste collection vehicles have an operational radius within which they are cost-effective. This operational radius is a function of the type of truck and the amount of waste collected as well as the physical conditions of collection routes within the collection area. Generally, if the travel time to a processing or disposal location is equivalent to or greater than half the daily time taken in actually collecting waste, a form of transfer should be considered. Although transfer operations offer potential savings, they involve an additional handling step with an associated cost that needs to be factored into the decision on whether to build a transfer station. Therefore, the economics of constructing and operating a transfer station must be thoroughly evaluated to verify that this is the most cost effective way to transportwaste to aprocessing/disposal location.

Transfer refers to the movement of waste materials from a primary collection vehicle to asecondary (generally larger and more efficient) transport vehicle through a transfer station or consolidation containers for transport to a final destination. While all solid waste systems usually include collection, they may not require transfer depending on the proximity of processing or disposal locations to the municipal collection points or routes. The location of transfer stations should be based on the following factors:

1. The neighborhood in which the transfer station is located should be willing to accept the transfer point as may be defined.
2. Odor noise and increased traffic should be minimized during the operation of the station through effective operation and maintenance.
3. The transfer station should be close enough to the collection area so that the primary collection vehicles can quickly return to their collection routes and continue their principal collection function.
4. The site should have easy access to major roads.

5. An analysis of direct haul time from collection locations and routes to processing or disposal location will determine the time that can be saved through transfer.

In many large and heavily populated areas or in regions with dispersed population centers, morethan one transfer station may be required. This may be a likely scenario in Georgia where a number of municipalities will, likely, be served by regional landfills. The appropriate number of transfer stations willdepend primarily on the number and size of individual service areas and zones and the distance between them.

There are a number of environmental benefits associated with transfer stations since they help to reduce air emissions and fuel consumption. In addition, access to solid waste at a transfer station may help increase recovery rates. The availability of transfer stations also will allow landfills to become free of the movement of collection vehicles. This allows disposal locations to be sited with more consideration for public health and environmental factors rather than their location in proximity to waste generators and collection routes.

Transfer Station Design - Transfer stations should be designed to be convenient and safe with appropriate storage for the solid waste received from the collection vehicles. The transfer station operating scheme should be as simple as possible and should require a minimum of waste handling while offering the flexibility to modify the transfer facility when needed. The following are general criteria to be considered intransfer station design:

1. **Site** - The site for transfer stations must be large enough to accommodate buildings, waste storage, vehicle maneuvers, and potential for expansion. To the degree possible, the sites hould have sufficient elevation change to accommodate a two-level building or site design for gravity transfer purposes.
2. **Transfer Techniques** - There are three types of transfer stations commonly used where collection vehicles discharge waste 1) onto a tipping floor, 2) into pits or hoppers for compaction or 3) directly into transfer trailers. When vehicles are emptied onto a tipping floor, additionalequipment such as a front-end loader is needed to push the waste into the receiving transfer vehicle or into a hopper of an external stationary compactor at the station. Basic criteria for each type of transferstation is as follows:

   Open tipping floor transfer stations

   - Usually more efficient for small quantities of waste
   - Can be used to transfer different materials into different vehicles
   - Can easily accommodate recovery of materials with recycling value
   - Allows for waste picking during transfer
   - Maximizes the possibility of spreading out the waste to dry it prior to transfer

   Open pit transfer stations

   - Allows multiple collection vehicles to offload at the same time.
   - Can accommodate larger collection vehicles.
   - Higher capital and operating costs than open tipping floor concepts
   - Preprocessing and separation of recoverable materials is difficult.

   Direct dumping transfer stations

- Have no intermediate handling which increases efficiency and decreases labor requirements
- Does not permit waste picking
- Requires bi-level construction with receiving trailers at a lower level
- Can be quickly constructed or moved and are relatively inexpensive
- Requires sufficient numberof trailers depending on amount of waste received and the distance to processing or disposal locations.

Typically, small scale transfer stations are direct-discharge stations that provide no intermediate waste storage. These stations may also have drop-off areas for use by the public in the vicinity of the station in addition to the principal operating areas dedicated to the receipt of waste from the collection trucks. Depending on location, site aesthetic requirements, and environmental concerns, transfer operations of this size may be located either indoors or outdoors and are usually attended during hours of operation.

Smaller transfer stations used in rural areas often have a simple design and, in some cases, are left unattended. These stations consist of a series of open-top containers that are filled by station users. These containers are then emptied into a larger vehicle at the station or directly hauled to the processing or disposal site and emptied. For ease of loading, a simple retaining wall commonly allows containers to be at a lower levelFactors that should be considered in determining the appropriate capacity of a transfer facility include:

- Capacity and type of collection vehicles using the facility,
- Desired number of days of storage space on a tipping floor, if any,
- Time required to unload collection vehicles of all types bring waste to the station,
- Peak number of vehicles that will use the station and their normal hours of arrival,
- Whether waste sorting or processing is to be accomplished at the facility,
- Transfer trailer capacity (in use and standby),
- Hours of station operation.

Transfer Station Development Procedures – The following are the general steps commonly used in assessing and implement transfer stations:

Step 1: Assess Waste Transfer Applicability – The intent of the first step is to determine if theeconomic benefits of transfer outweigh the costs associated with the process. This can be determined by accomplishing a break-even analysis which includes the following factors:

1. Transfer station and processing/disposal site locations.
2. Average payloads of collection vehicles and transfer vehicles.
3. Travel speeds and distance for collection and haul vehicles.
4. Transfer facility size, technology, and operating practices.
5. Collection and transfer vehicle unit and full operating costs.

To calculate the break-even point for waste transfer, first determine the following values:

- Transfer Station Cost including the cost to build, own, and operate the transfer station, in Lari per ton.
- Average payload of collection vehicles hauling directly to a processing or landfill location, in tons.

- Average payload of transfer trucks hauling waste from the transfer station to the processing or disposal facility, in tons.
- Transportation Cost: average cost of direct or transfer hauling, in GL per km.

Once these values are known, calculate cost for different transport distances to final destination areas.The first calculation would be for the cost of direct haul without the transfer station which iscalculated through the following formula:

$$\frac{\text{Distance (km) x Transportation Cost (GL/km)}}{\text{Direct Haul Payload (tons)}}$$

The comparable cost with the incorporation of a transfer facility can be calculated using thefollowing formula:

$$\frac{\text{Transfer Station Cost (GL/ton) + Distance (km) x Transportation Cost (GL/km)}}{\text{Transfer Haul Payload (tons)}}$$

In developing the break-even analysis, a graphical representation of the costs can be developed.An example of such a diagram is shown in the following figure. If the distance from the endpoint of all of the collection routes to the processing/disposal facility is **less** than the break-evendistance calculated, then there is no benefit from waste transfer. However, if the distance from the end of some or all of the collection routes exceeds the break-even distance calculated, then there is potential benefit in implementing a transfer station.

Step 2: Develop the Conceptual Design for the Transfer Facility– If clear economic benefits can be determined through the above break-even analysis, then the next step should be to develop an assessment and conceptual design that seeks to answer the following questions:

1. What materials will the transfer facility accept? (Commonly accepted materials include: municipal solid waste, green waste, household hazardous waste, recyclable materials, construction and demolition debris).
2. What average volume of material will the transfer station manage?
3. How much waste will the facility receive during peak time periods?
4. Will the transfer station receive waste directly from the nearby waste generators or limit access solely to municipal and/or contractor waste collection vehicles?
5. What additional functions will be carried out at the transfer station (i.e., material recovery, special waste handling, and vehicle maintenance, etc.)?
6. What are the physical characteristics of the collection vehicles that will use the facility?
7. How much waste storage space is needed?
8. What type of transfer technology and haul equipment will be used?

Step 3 - Determine the Transfer Station Size and Capacity –The next step is to determine the required size and capacity of the station.There are a number of factors thatinfluence this including:

1. The extent of the service area.
2. The amount of waste generated in the service area.

3. The number and types of vehicles delivering waste.
4. The types of materials to be transferred.
5. The type of transfer equipment to be used.
6. Waste tonnage projections over the station's expected life.

9. Implementing an effective collection system

As with most modifications to waste collection systems, a change in routing or collection frequency affects at least three groups of people: 1) those responsible for managing the collection system, 2) the collection crews, and 3) waste generators. Information should be provided to properly inform each of these groups about what isexpected of them and enlist their cooperation in accomplishing the desired change and in the performance of the resulting collection system. The solid waste collectors and drivers should be informed of all proposed changes to the collection system and encouraged to comment on the effect of the changes will have on their daily operations. The workers' participation in reviewing the decisions may be a useful managerial tool in that it helps them feel a part of the new system decision making and more in support of the change that may be required.

Several mechanisms can elicit cooperation from the collection personnel and help improve or maintain employee morale during and after implementation of an upgrade or modification to the collection system. Other public officials also should be apprised of the proposed changes as the new transfer system or collection system modifications are implemented. If the reasons for the changes in the collection system are explained to them, they often become important allies during the transition.

The implementation of the technical portions of a new collection/transfer approach should be phased as the need for transfer evolves due to the development of the regional landfills and the closure of the uncontrolled dumps. As a result, collection system managers will need to plan their system modification service area by service area. An overall plan should be developed defining the technical changes to be accomplished and the schedule for securing the necessary resources to accomplish the change and putting them into service.

10. Design and Implementation of Separate Collection Programs

Article 13 (Section 5 (e)) of the Waste Management Code requires that municipalities include planned measures to be taken for the establishment of separate collection and recovery of municipal waste, including of biodegradable waste and packaging waste as components of their municipal waste management plans. The deployment of separate collection for recyclable materials is expected to occur on a phased basis as source separation program evolves. Accordingly, the initial phases of source separation may require significantly less separate collection assets (trucks and containers) that will eventually be the case.

Alternative approaches are utilized to implement source separation collection programs. These alternatives commonly depend on the type of materials collected and whether individual containers are provided for each material or for a common container for a number of recoverable materials that then need to be sorted at a centralized facility.

11. Dealing with Waste Materials with Unique Properties

Bulky Waste – Bulky waste can include a variety of materials which because of their size cannot be managed through the conventional waste collection system. This can include items such as discarded furniture, end-of-life refrigerators and stoves, and any other waste material that cannot be effectively managed by the residential waste collection program. In some cases, the management of bulky waste requires a level of treatment to prevent environmental damage. For example, the means for removing and properly treating refrigerants from end-of-life refrigerators may be important to prevent chlorofluorocarbon (CFC's) emissions to the atmosphere thereby controlling the climate change effects.

Bulky waste can be collected in a number of ways. Since the generation of this kind of waste is often at irregular intervals, a municipality may provide an on-call service which collects bulky waste on request. For this approach, households and businesses are informed of a telephone number which they can dial (or an office they can visit) to request that items or materials be collected from their premises. The bulky items to be collected must be clearly described or labeled so that other items are not inadvertently removed in error. A fee may be charged for this service. If this is the case, people may dump their bulky waste on open ground in order to avoid this fee. This requires strict enforcement of litter laws to prevent this informal disposal activity. from where it may be more costly to collect it.

If bulky waste and green waste from gardens are generated at reasonably predictable quantities or times, a municipality may deploy large containers at times that are announced so that residents can carry their bulky or green waste materials to the containers and deposit the material inside them. The containers should then be removed and emptied. In waste generator locales near transfer stations or disposal areas. Locations may be designated at these facilities for receipt of such materials directly from generators.

12. OPERATING AND MAINTAINING AN EFFECTIVE COLLECTION SYSTEM

Manage Collection System Operations

An effective waste collection system requires firm and thorough administration and control of its operational and maintenance functions. From the perspective of managing each waste collection component, effective administration and control requires that all personnel involved in the process be held accountable for their performance. To achieve this,system administration should, at a minimum, include effective branding, record keeping, direct monitoring of systemperformance through inspections and observations, supervision of maintenance, dedication and availability of standby equipment, and effective full cost accounting.

Branding provides a means for clearly identifying the responsibility for the waste collection assets deployed by a municipality. Utilization of common colors, a sponsoring institution logo, contact information, etc. on collection vehicles can be important in convincing a municipality's population that an effective systems is in place. This can help achieve a good impression on the part of the municipality's population about the collection service provider thereby supporting a willingness to pay for an effective service on the part of waste generators. Keeping collection vehicles in good working order and clean is an important way of providing the correct impression of the effectiveness of waste collection service.

Record keeping is very important in monitoring and documenting the collection system performance and its effectiveness. Without proper records, productivity measurements, evaluations, cost studies and preventive maintenance, it will be impossible to accomplish and sustainan effective level of collection service. Collection system records that should be routinely kept by a municipality include:

1. Route maps
2. Vehicle records including purchase data, maintenance and repair records, fuel consumption records, accident reports, operating hours, on route hours, time to processing or disposal sites and return
3. Crew-related records including amount of waste collected per day, households or containers serviced per day, time on-route, time off-route
4. Waste related records including weight, number of trips to processing or disposal sites per day, percentage of full capacity determined by weight records per delivery, etc.

These records will be important to monitor the performance of the collection program and will serve as the basis for planning and designing service expansions and new facilities such as transfer stations.

Train personnel

All collection personnel need to be properly trained in the performance of the duties. The training should define and help assure the level of productivity expected of them. At a minimum, training should be provided for the following:

- Routing structure and expected collection productivity
- Record keeping
- Health and safety
- Contingency procedures in the event of accidents, injuries, spills, etc.
- Operations and maintenance procedures for collection equipment.

In addition to the above base training content, specialized training should be provided to collection system managers who will be responsible for monitoring and inspecting system performance. This management training should also include training in system design (such as routing analysis) to allow for continual tracking of performance and system needs identification and implementation. Specific training should also be provided to personnel responsible for maintenance of all collection equipment.

Develop Contingency Procedures For Unusual And Special Circumstances

Effective collection and transfer systems requires that contingency procedures be established for any unusual and special circumstances that may arise. At a minimum, contingency procedures should be established for the following:

1. **Accidents** - Given the nature of motor vehicles and the collection process, accidents may be expected to occur. These accidents may solely involve collection system vehicles and personnel but may also involve others. Any accident should be immediately reported and investigated to determine its extent and cause. Contingency procedures concerning accidents should be a function of the severity of the accident. All collection personnel should be trained as to any contingency procedures to be used in the event of an accident. Collection crews should be particularly trained as to the procedures in the event of an accident where somebody is seriously hurt. In the case of a life-threatening situation, personnel should be prepared to take required actions including emergency first-aid and the immediate notification of other sources of emergency assistance.

2. **Complaints** - Complaints may be received concerning the collection system. All complaints should be logged and investigated by system administrators. As is the case with procedures to address accidents, complaints should be expeditiously evaluated to determine their cause and to address the reason for the complaint. Adjustments may need to be made to the collection system to eliminate the cause ofjustifiable complaints especially those that may be recurring. As a contingency procedure, collection system managers should be prepared to address issues such as overflowing containers or the accumulation of waste in areas where it is not intended. It is extremely important that such complaints be addressed in a timely and thorough manner since a small accumulation of waste in anuncontrolled location can become a major project to clean-up if allowed to grow.

Develop And Manage An Effective Maintenance Program

The successful operation and productivity of any collection or transfer system is dependent on the manner in which its various components are maintained. In addition to proper maintenance, sufficient back-up equipment must be available to assure that each collection cycle can be achieved with a minimum of disturbance or variation to service schedules and efforts. Effective routing, operation, preventive maintenance and repair work can contribute to increasing long-term vehicle productivity and availability. A key basic element of a regular maintenance program should include the need for keeping the collection vehicles in a clean condition. Since collection vehicles will be observed on a daily basis by a municipality's population, condition of the vehicles should be reflective of an efficient service.

Types of Maintenance - There are two types of maintenance that need to be done on a day-by-day basis including repair and preventative maintenance. Experience has shown that wherever mechanized equipment is used, there is a direct relationship between the degree of preventative maintenance and the level of repair required. Logically, there is a level of preventative maintenance where the cost effectiveness of a maintenance program is lost. An extremely high level of preventative maintenance can theoretically lead to performance levels where few breakdowns in mechanical equipment are experienced. However, the cost of this idealistic level of preventative maintenance will, likely, be prohibitive. Similarly, the cost of repair maintenance, where little or no preventative maintenance is done, may also be very high. The design of an effective maintenance program attempts to establish the optimum balance between repair and preventative maintenance that would be most cost effective.

Repair Maintenance - Repair or corrective maintenance consists of making repairs when they are required because of equipment breakdown. Since breakdowns cannot be planned, the consequential loss of some equipment as a result of repair downtime must be added to the overall cost of a repair to determine the full economic impact of breakdowns. Additionally, backup equipment is required and should be available so that the level of service is not affected by equipment breakdowns.

Preventative Maintenance Program Structure

Maintenance Systems Management

Preventative Maintenance – By definition, preventative maintenance consists of the following:

1. Periodic inspection of equipment to uncover conditions that could eventually lead to breakdowns or harmful depreciation.
2. The avoidance of future difficulties by making minor repairs in advance of major problems.
3. Replacements, adjustments, major overhauls and inspections that are preplanned and scheduled on a cycle that will maintain equipment at the optimum operating efficiency.
4. A policy of operating equipment properly and within its range of design capability.

An effective maintenance program design normally assumes that both preventative and repair maintenance are made part of regular operational procedures. The emphasis of the maintenance plan, however, should be on preventative maintain procedures that minimize the level of repairs required. Preventative maintenance activities are usually preplanned and scheduled, thus facilitating the programming of maintenance work. This significantly improves the planning and scheduling of all maintenance management activities. The experience gained as collectionequipment is operated helps to identify "critical"components that should receive priority in themaintenance program. An effective preventative maintenance program is broken down into threecategories including: 1) monitoring, inspections and tests, 2) routine upkeep tasks and 3) fixed and variable interval major tasks which are further described as follows:

- **Monitoring, Inspections and Tests** - The inspection of critical equipment is a key part of any PM program. The purpose of inspection is to identify and correct unfavorable conditions that may be developing. This can help prevent breakdowns. Inspection activities may be accomplished in a variety of ways such as visual inspections, monitoring of normal operating parameters, measuring and analyzing data, and the performance of specific tests. The primary types of visual inspections which are normally included in an effective PM program are as follows:
    - **Vibration Monitoring** - Simple monitoring of vibration levels through touch or noise of major components of mobile equipment is very effective way of detecting potential failures and allowing corrective action to be initiated before major breakdown occurs. Many major equipment failures can be predicted by vibration monitoring.
    - **Monitoring Parameters** - The periodic monitoring or, in many cases, continuous monitoring of operating parameters, such as engine operating temperatures,operating liquid levels, etc. provides a relatively simple method of detecting impending problems or failures.
    - **Noise Levels**- Unusual noise or sounds emanating from operating equipment may indicate a problem or potential breakdown. The monitoring (and reporting) of noise levels with the human ear during the course of normal operating duties can provide good input to a preventative maintenance program. Operating staff, as well as maintenance staff can provide this

monitoring with subsequent reports to management. In operating equipment, one becomes acclimated to the sound that is expected.

  - **Equipment Cleanliness** - The cleanliness of equipment can provide useful information regarding operating conditions. Oil, water, and hydraulic fluid accumulated under or leaking from equipment is a good indicator of leakage or malfunction.
  - **Lubricant Condition** - Periodic inspection and testing of lubricants used in mobile equipment provides an excellent means of predicting equipment failures. Both visual and chemical analyses may be used to determine lubricant condition.
  - **Functional Tests** - In some cases, it is necessary to physically test equipment to assure it is performing within its specifications. Functional tests of individual components, either on a special or routine basis, can provide data that can be used to assess equipment conditions and the need for repairs.
  - **Safety Inspections** - Safety inspections should be conducted on a routine regular basis to assure that potential hazards to the public, operating personnel and equipment are identified and that corrective actions are immediately initiated.

  The above listing is not necessarily complete. However, it provides a basis for initiating a comprehensive preventative maintenance program. As the PM program matures, additional inspections and tests may be incorporated into the program that are based on the experience gained in operating and maintaining the equipment.

- **Fixed and Variable Period Maintenance** - The performance of routine periodic maintenance improves equipment reliability and extends service life by maintaining optimum equipment conditions. The routine upkeep tasks on individual equipment usuallyrequire a short time to complete and are normally conducted on a regular schedule by maintenance staff or members of the collection crew. Typicalroutine upkeep tasks on motorized equipment can include: 1) lubrication, 2) filter/strainer change/cleaning, and 3) cleaning and painting.
- **Major Preventative Maintenance Tasks and Overhaul** - The final category of activities is fixed and variable interval major preventative maintenance tasks. Mobile equipment may beroutinely removed from service for extended periods for inspection and overhaul. The frequency and duration of such overhaul periods varies with the type and use of the equipment.

So as to establish the control and management accountability required in a good preventative maintenance program, checklists and records of task performance should be used to maintain a database of all work done. Maintenance staff and equipment operators should be required to complete checklists of the repair and maintenance tasks that they perform.

Standby equipment - Solid waste collection is a difficult process and equipment used within the collection system will often break down. To maintain a proper level of service, standby equipment may be required so that the collection system can still function even when some primary equipment is broken down. Inindustrialized countries, the target level of standby equipment is to provide at least one standby vehicle for every five vehicles in daily service.

13. Monitor system performance and adjust the collection system as necessary

Reducing collection costs by improving collection efficiency must begin with a thoroughunderstanding of the activities that occur during the collection process and time. The collection time can bedivided into two broad categories for purposes of analysis:

1. Time spent on nonproductive activities when the collection crew is not occupied withcollecting waste from collection routes or communal containers
2. Time spent actually collecting waste along the collection routes or in servicing container locations.

Allocation of the work day among all the productive and nonproductive activities can be determined by recording the amount of time personnel spend on each activity from the moment they start work in the morning to the moment when they leave work at the end of the day. The following areas of unproductive time deserve particular attention in monitoring the performance of a collection system:

- Where possible, trucks should be assigned to a single driver over an extended period of time, so that time is not lost changing mirrors, getting personal items out of trucks and rechecking engine fluids and equipment. This also makes it easier to track driving habits to assign blame and praise for high and low repairs on individual vehicle.
- Routine maintenance should be accomplished at the end of the collection day preferably bymaintenance crew rather than the driver.

By regularly monitoring the time spent on various activities, a collection system can beeffectively monitored to assure maintained productivity. After a while, a level of performanceproductivity will be obvious to municipalities so that it can be monitored. If the system is designed properly and sufficient resources are available, evidence of system failure (waste accumulation outside of containers, inconsistent service, complaints, etc.) will be an indication of productivity slippage thereby warranting closer investigation of system productivity and asset management processes.

Private Sector Participation

In the future, the role of the private sector in waste management may become more prominent in Georgia. In many countries, private companies have been able to bring the required capital and operating efficiencies that have helped municipalities save money while achieving better waste management results including service expansions. However, experience with such approaches has been minimal in Georgia because of legal restrictions affecting municipal service contracting. In the future, private contractors may provide a means for incorporating more sophisticated technology inachieving waste collection, treatment or disposal that conforms to international sound practice and is in full compliance with the Georgian Waste Management Code.

Utilization of a private contractor also allows the establishment of contracted performance standards that a contractor is required to follow. To accomplish this, performance standards may be defined in a contract for the private contractor service. For example, if a municipality contracted a private contractor to providecollection services, the municipality could require a minimum stipulated level of service as a condition of theservice contract. This would allow municipal officials to monitor the performance of a contractor to assuregood service. Inmany areas of the world where private sector contracts have been established, penalties are oftenstipulated incontracts for poor performance. This serves as an incentive for contractors to maintain the contracted level ofservice.

Securing a private contractor for collection and transport services should be undertaken in aformal and transparent manner in accordance with all applicable Georgian laws and regulations that govern public procurement processes. In preparing for a contractor solicitation process, a municipality must be prepared to clearly define what services that a contractor will be asked to provide. Technical information concerning the existing collection and transport service should be prepared to serve as a basis by which a private contractor will determine the extent and cost of the services they must provide if awarded a contract. The documents prepared for the solicitation process should strive to assure that all prospective contractors are being asked to provide proposals on a common set of requirements and proposal evaluation terms. Suggested content for a contractor solicitation should include the following elements:

1. Background and information on the municipality and the current collection/transport program
2. Service and performance standards to be met by the contractor
3. The proposed term and scope of the collection contract (If a contractor is requested to provide their own vehicles for collection and transport purposes, the contract term should be a minimum of 5 years to allow the contractor to capitalize the equipment to be provided for the service.)
4. Services and equipment to be provided by the municipality and that may have to be provided by the contractor.
5. Criteria by which contractor proposals will be evaluated
6. Proposed contract terms and conditions

Once proposals have been received in accordance with the municipalities terms of reference, they should be evaluated and a selection made of a preferred contractor for negotiations. Negotiations that ensue define any issues that may exist and to establish the contract for the intended service.The contract negotiated between the municipality and the preferred contractor should include a clear description of the services to be provided in the performance standards that must be met by the contractor over the term of the service provision.

One key issue that will need to be considered in developing a contract with a private sector contractor may be the existing equipment and personnel associated with the municipalities current service. If the contractor is to assume responsibility for utilizing as a pallet these equipment or employing the personnel that were deviously responsible for the collection service as municipal employees, this should be properly defined and stipulated in the service contract. Additionally, the contract negotiated between the municipality the contractor the provisions for monitoring and evaluation of the contractor’s performance to determine that that they are meeting contract requirements.

14. Public Awareness, Cooperation and Participation

Strong public awareness of waste management issues is critical if an effective waste collection system is to be realized in Georgian municipalities. Public attitudes towards litter and the improper dumping ofwaste in random locations must be adjusted by education and reinforcement of litter penalties defined in the Waste Management Code so as to not place an additional burden on the collection system.

The public awareness program needs to create a clear linkage between the roles that each residential and commercial waste generator has in the efficiency of the overall collection system and its long term success. It alsoneeds to create a means by which waste generators can feel that they “own” the solutions that are implemented. This requires that the means for soliciting public input into the waste management planning process be developed.

The public awareness program should also attempt to create a linkage between the actual costof a reasonable level of collection service and generator willingness (and ability) to pay. Throughout theworld, experience has shown that people are willing to pay more for an improved level of waste collection service. However, in some locations, fees have increased without realizing a significant improvement in service. This then has significantly reduced the resources required to enhance services.

Annex 2

TECHNICAL MANUAL FOR MUNICIPAL WASTE TREATMENT

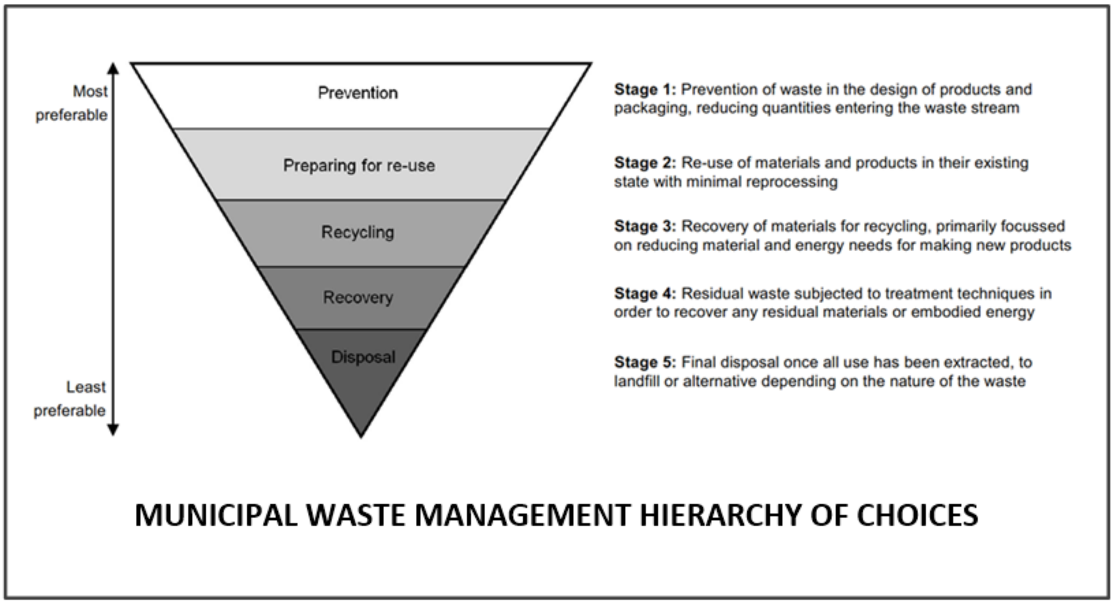
1. APPLICATION OF THE WASTE HIERARCHY

Globally, most countries of the world have adopted the waste hierarchy shown below to serve as a key principle for their Integrated Solid Waste Management (ISWM) systems and as a means for defining the priorities and options for selecting viable waste treatment approaches. The focus of the individual waste hierarchy tiers is to prioritize activities that eventually lead to minimizing the need for landfill disposal and treatment related environmental impacts while maximizing the benefits derived from recovery processes associated with some treatment approaches.

Section 1 of Article 4 of Waste Management Code includes waste management hierarchy.

Waste hierarchy is shown by using a pyramid configuration (as shown in the schematic) which supports the implementation of the 4 R's commonly associated with ISWM processes. In their sequence of priority, the 4 R's include the following:

- **Reduce** – These processes seek to reduce the amount of waste generated at its source or to reduce the hazardous content of the waste prior to its entering the waste stream.
- **Reuse** – These processes seek to reuse a material or product at its source rather than wasting it. This is accomplished through concepts and initiatives such as producer responsibility policies, waste exchanges between manufacturers, and the industrial use of recyclables as manufacturing feedstock.
- **Recycling** – These processes seek to separate waste commodity materials such as paper, plastic and metal, by source separation and separate collection or by mechanical processing means such as through the use of manual sorting conveyors, screens, magnetic separators, air classifiers.
- **Resource Recovery** – These processes seek to produce new resources from the waste materials utilizing techniques such as gasification which can lead to the production of synthetic fuel, biological digestion which can lead to the production of biogas, anaerobic decomposition which can lead to the production and sale of compost and incineration which can lead to the production and sale of electricity.



While reducing and reusing waste materials are the highest priority of choices to divert waste components from landfill disposal, recycling is the preferred technical option for environmentally processing municipal waste streams that can also lead to landfill diversion while realizing substantial natural resource savings by offsetting the energy utilization that would have been required through mining, planting, processing, transporting, and/or manufacturing the material that is being displaced by the recyclable content.

Any method utilized for municipal waste treatment must:

1. Encourage the prevention, recycling and processing of waste;
2. Ensure that, as far as possible, potential negative effects on the environment as well as any risk to human health due to solid waste will be mitigated as a result of treatment. (This must include the potential environmental effects that could be caused by the treatment process itself.)

2. Minimum Waste Treatment Requirements

At a minimum, the treatment of waste must:

1. Be a physical, thermal, chemical or biological process including sorting.
2. Change the characteristics of the waste; and
3. Meet objectives that:
   a. reduce waste volume; or
   b. reduce waste hazardous nature; or
   c. facilitate waste handling; or
   d. enhance waste recovery.

4. Inert waste for which treatment is not technically feasible or necessary;

5. Waste other than inert waste where treatment will not reduce its quantity or the hazards that it poses to human health or the environment.

3. Validation of Treatment Results

To assure that the required minimum level of treatment, treatment processes and facilities must successfully comply with a three-point validation test to be viewed as providing the required level of treatment and complying with the treatment requirements of the Waste Management Code and this Collection Treatment Technical Regulation. Criteria for this three-point treatment compliance test include the following:

1. **Test 1 - Process Applied** - The treatment method must comply with one or more physical, thermal, chemical or biological processes. Since some simple physical treatment processes could pass the first criterion of the three-point test but may not pass the other criteria, all three parts of the three-point test must be applied to a treatment process if it is to be considered a valid treatment method that meets the requirements of the Waste Management Code and this Technical Regulation.
2. **Test 2 - Change in Waste Characteristics** – Waste characteristics are the key properties that define its potential impact on human health or the environment when placed into a landfill. As a result, the selected treatment method must accomplish a meaningful change in waste characteristics. The waste characteristics which could be changed through effective treatment must include:
    a. **Leachability** - Lowering the leachability of a waste through physicochemical means.
    b. **Biodegradability** – Lowering biodegradability through the utilization of anaerobic decomposition or another form of biological treatment such as composting.
    c. **Combustibility** – Reduction of combustibility and physical characteristics through thermal treatment such as incineration for energy recovery.
    d. **Physical form** – Change in the physical form of a waste will not be accepted as a valid treatment unless that treatment involves a corresponding change in the other characteristics of the waste. (For example, wetting a dusty waste or compacting a waste are not acceptable treatment methods because they do not change the characteristics of a waste. Similarly, bagging or otherwise containerizing a waste does not change its characteristics.)
3. **Test 3 - Treatment Outcomes** - In addition to complying with the test 1 and 2 criteria shown above, the treatment method must also derive meaningful outcomes. At a minimum, valid target outcomes to qualify a treatment process under this testing tier will:
    a. **Reduce waste volume** - Examples of processes that do change the characteristics of the waste in order to reduce the waste volume landfilled include: the incineration of waste, the sorting of waste to divert waste components from landfill disposal, or the composting of source separated organic waste. Reducing volume must be achieved

by removing an element of the waste in anticipation of its reuse, recycling or some other forms of recovery. (Processes that reduce the volume of waste by compaction (such as compacting household waste in a refuse collection vehicle, for example) do not change the characteristics of the waste so this process does not meet the second validation test.)

b. **Reduce hazardous nature** – Complying with this criterion depends on the type of waste being landfilled. For municipal waste, reducing its hazardous nature shall, at a minimum, include the removal of biodegradable waste to significantly reduce the residual wastes impact on methane production in landfills and its resulting impact on climate change.

c. **Facilitate handling** - Treatment methods that change the characteristics of waste in order to facilitate handling relate to the waste handling activities that take place upon the placement of the waste into a landfill but are not applicable to handling of the waste prior to landfilling. When the proposed treatment is to facilitate handling, the change in characteristics must also reduce the negative effects of the landfilled waste on the environment or human health resulting from landfilling the waste. Examples include treatment processes that cause long-term change in the characteristics in terms of waste leachability, decomposition and the resulting generation of gas or odors.

d. **Enhance recovery** - Sorting or segregation does not necessarily enhance recovery unless the treatment process intends to recover part or all of the waste component and divert it from landfill disposal.

These testing criteria may require documentation of testing results, etc. to be presented to landfill operators as an indication that sufficient treatment has been applied to a specific waste stream prior to receipt at a landfill for disposal. In some cases, waste pretreatment may be provided at landfills as a means of meeting the treatment requirements of the Waste Management Code.

4. DESCRIPTION OF TECHNICAL OPTIONS FOR RECOVERY AND TREATMENT

The choice of a treatment technology, system or equipment shall, to the degree possible, be a function of the following factors:

1. Availability to assure sustained effectiveness as a result of readily available operational/maintenance supplies and spare parts sources;
2. Demonstrated reliability to assure continuing effectiveness of treatment;
3. Design sensitivity to waste characteristic (composition, density, etc.) changes to achieve adaptability, namely, gradual implementation of separate collection for recyclables;
4. Technical simplicity that allows sustained effective operational results with the minimum technical expertise and cost.

Some of the treatment processes that can fulfill the treatment requirements are described below.

4.1. Recycling and Resource Recovery Options

Recycling processing involves a facility with mechanical systems that sort, screen, clean, air classify, and magnetically separate materials from mixed wastes streams. The common output of processing municipal waste through these facilities includes: paper, cardboard, glass, metal, rubber, and plastics. Further, if a recycling process focuses on construction and demolition debris, processing output will include concrete aggregate, asphalt aggregate and metal. A critical factor in the economic feasibility of such processes is the availability of viable markets for recovered materials.

4.2. Source Separation and Separate Collection

As stipulated in the Georgia Waste Management Code, the gradual implementation of a process for segregating recyclable materials at source must be included in the development of municipal waste management plans. However, waste processing systems have been successfully utilized in many countries that effectively process single-stream waste content with good results.

In general, resource recovery systems available today are mature technologies with significant operating experience that allow reliable projections of what treatment results can be achieved in Georgian applications. This is especially the case for thermal conversion systems (such as gasification and incineration). In addition, improvements in the quality control of processing by-products available through the use of contemporary technologies have enabled output of products such as refuse-derived fuel and compost.

The technical approach that a municipality chooses to fulfill its treatment requirement depends on whether wastes are source segregated and separately collected or whether a mixed waste stream is collected. For that reason, in order to identify the viable technological options that may be available to municipalities, municipalities should consider various options for waste collection. Waste collection method has a significant impact on the technical choices for meeting the treatment requirement. Waste collection options are:

1. Source separation and separate collection of the different fractions of dry recyclables in the municipal waste stream such as paper, glass, plastic, metals
2. Source separation and separate collection of a comingled stream of dry recyclables (all the materials shown above in one collection container)
3. Source separation and separate collection of food waste and other high value organics
4. Mixed waste collection without any source separation
5. Residual waste collection (the remaining residual waste after source separation of dry recyclables and organics)
6. Wet fraction residual waste (the remaining residual waste after source separation of dry recyclables but without the source separation of organics).

Selecting the best collection approach points out the relationship of the collection methodology can havewith treatment options. Institutions responsible for waste collection in Georgia may choose among the following collection options that will influence the choice of treatment methods. Waste collection methods are:

1. **One-bin collection system**: A system without any source-separation of waste components, where all mixed waste is collected in a single container.
2. **Two-bin collection system**: A system with source-separation of comingled dry recyclables (paper, plastic, metals, glass) in one collection container and collection of the rest of the wastes (residual waste) in a second container.
3. **Three-bin collection system**: A system with source-separation and collection of comingled dry recyclables (paper, plastic, metals, glass) in one container, source-separated high-value organic wastes in a second container and all remaining residual waste in a third container.
4. **Multi-bin collection system**: A system with various combinations of dedicated containers for source separation and independent separate collection of dry recyclable components (paper, metal, glass and plastics) and organics.

Resource recovery processing involves three basic approaches for treating waste and converting organics in waste to a new resource, as follows:

- biological conversion,
- thermal conversion, and
- mechanical conversion.

4.3. Biological Conversion

Biological conversion utilizes micro-organisms to convert the putrescible organic content of a waste stream under either aerobic or anaerobic processing conditions to derive end-products such as compost or biogas. The two common biological conversion methods utilized for municipal solid waste are composting and anaerobic digestion. There are many vendor variations for biological conversion systems, but they all fall under these two categories of biological conversion. Typically, the micro-organisms that work in the aerobic process of composting are more robust and less sensitive than those that function in anaerobic systems. However, both conversion systems require careful attention to the control of the environment for the micro-organisms and the conditions that support and sustain their growth and function. Biological conversion facilities are processing putrescible organics and can attract insects and birds. The main pollutants that may be emitted from biological conversion systems are fine particulate and bio-aerosol emissions that can trigger respiratory disease if not properly controlled.

4.4. Thermal Conversion

Thermal conversion involves the use of heat and possibly pressure to convert any type of organic material within the waste stream to either syngas, synfuel, or steam for electricity generation. The most common thermal conversion methods are combustion and gasification. Under gasification, there are technical variations that are available, such as gasification to syngas, pyrolytic gasification to oils and gas, and plasma arc which is an extremely high temperature gasification process. In utilizing incineration as a treatment process, the system variations offer different feeding rates and furnace designs to accommodate alternative design capacities that are defined by the extent of a municipal solid waste stream. All of the thermal conversion processes have similar types and levels of emissions and all are subject to similar economies-of-scale benefits.

Because of the potential for hazardous emissions from thermal processes, the EU's 2000 emission standards were implemented to establish the maximum emission levels necessary to safeguard the public against health risk. The emissions of greatest concern with incineration and gasification are volatilized heavy metals (including lead, cadmium and mercury), volatile refractory organics, and dioxins and furans. As a result of thermal processes, these materials can be emitted as air emissions that can be transported a long distance if not properly captured through air emission control systems. Fine particulates can also be emitted from a thermal process stack and can trigger health effects such as respiratory disease particularly in vulnerable populations (elderly, et.). A key factor in the implementation of thermal conversion systems is that the air pollution controls that are mandatory for these technologies (as defined in the EU emission regulations) have a cost and land area requirement that is roughly equal to the thermal conversion facilities alone. This establishes a minimum economy of scale for such installations.

4.5. Mechanical Conversion

Mechanical conversion is accomplished through the use of simple mechanical systems that sort, screen, and pelletize waste components to process dry organic materials into refuse-derived fuel, or the more stringently quality-controlled secondary recovered fuel that is able to meet EU import standards. As with any handling systems for solid waste, localized air emission of fine particulates and dusts are possible and must be managed through effective design and operation. However, there are no high temperatures involved in this means of processing to create the type of emissions derived from thermal conversion and require stacks to discharge air emissions. An important aspect of creating refuse derived fuel through mechanical processing is that special emission requirements may be necessary for any industrial burners or cement kilns that may use such fuels. This is due to the fact that the emissions that could result from using refuse derived fuel are different than those that result from the use of coal or other solid fuels for which the existing furnaces have been designed.

4.6. Landfill with Pre-Processing

Landfill with pre-processing can reduce the landfill space requirements and emissions and may serve as a means for meeting the treatment requirement. Pre-processing of the mixed wastes is conducted before the wastes are placed into the landfill. The first level of pre-processing places the mixed wastes into windrow piles. The windrow piles are normally turned weekly so that the putrescibles in the waste area partially decomposed prior to placement into the landfilling. This helps to reduce leachate and biogas emissions at the landfill, as well as operational issues such as odors and the attraction of vectors such as birds. Additional pre-processing steps of sorting and screening out recyclables and combustibles could also be used to enhance the pre-processing result.

5. ECONOMIES-OF-SCALE OF TECHNICAL OPTIONS

The municipal waste sector has few IWM components that have major economies-of-scale. Therefore, large service areas for waste collection and some processing techniques are not required. But, for complex facilities such as sanitary landfills and waste-to-energy facilities, economies-of-scale are necessary and must be carefully considered in planning and design. Economies-of-scale always require local cost analysis to be determined accurately. Common economies-of-scale related to treatment options include the following:

1. Manually operated compost production facilities can be small and decentralized at a community level since there is no economy-of-scale requirement for such facilities.
2. Mechanized composting facilities that utilize numerous mechanical systems such as trommel and vibrating screens, sorting belts, and mechanical windrow turning equipment, may need to be large enough to fully economically justify the purchase and operation of the equipment. Wheeled loaders and windrow turning machines are the key size determinants in a mechanized compost plant. Windrow turning machine vendors have product lines that handle as little as 100 tons/hour. For economies-of-scale, assuming compost pile turning at least once a week for 6 weeks, therefore 100 tons/day could be an economically sufficient configuration.
3. Waste-to-energy facilities operate on a 24 hour basis and need to be large enough to justify the cost of the thermal equipment and its related air pollution control systems. Waste-to-energy facility vendors have product lines that handle as little as 50 tons/day in gasifiers or 120 tons/day in incinerators. While smaller sizes are now possible, economies-of-scale exist for all waste-to-energy conversion methods and a minimum size of 300 tons/day is a reasonable economy of scale. This may require a regional application to have sufficient scale to justify the use of this kind of technology.

The above discussion outlines minimum needed economies-of-scale for some of the treatment technologies available to Georgian municipalities. Most facilities become less costly on a per unit ton basis if they are larger. For example, while economically a waste-to-energy plant should be at least 150 tons/day and sanitary landfills should be at least 300 tons/day, many new facilities are striving for lower costs by handling significantly larger quantities of waste.

6. COMPARISON OF TECHNICAL OPTIONS

6.1. Cost/Benefit Analysis of Options

For planning purposes, municipalities must determine the direct costs of various treatment alternatives quantitatively through preliminary estimates using local unit cost factors. These estimates should then be compared with cost data for the evaluated technology that is widely available from various media sources. This will help to determine whether a particular technology application will be economically viable.

6.2. Qualitative and Quantitative View of Life Cycle Costs

Media sources can also be used to compare the estimated life cycle costs of a specific technology application in Georgia with similar life cycle cost analysis of like technologies in other areas. Life cycle costing provides an economic summary of all costs associated with equipment units or individual facilities over the economic life of the main treatment and processing components. This life cycle assessment should include full capital, operating, maintenance, and replacement costs over the economic life of a facility and its technical components.

Comprehensive decision models are available for life cycle analysis of various treatment options. (Interestingly, when the costs of all externalities are quantified, processing options that achieve significant recycling and resource recovery have such a large savings in natural resource consumption that they are very cost competitive with seemingly inexpensive options such as sanitary landfill.) These computerized life cycle assessment models have significantly altered the manner in which technical options are able to be compared and evaluated.

The following table compares the various treatment technical options discussed above relative to key viability factors including capital cost, recurrent operating and maintenance cost, revenue prospects, skill requirements, and land area requirements. The comparison also shows whether facilities derived from each technology choice are likely to be developed locally or regionally where an appropriate economy of scale becomes important in determining cost effectiveness and economic sustainability. It is expected that all of the technical options will be designed and sited to meet internationally accepted standards for environment, health and safety, and so it is not necessary to compare them from that perspective.

While this summary helps to identify the best technical choices that are available to improve solid waste management conditions in Georgia, the selection of the best technical applications and enabling framework arrangements will be a function of a number of development factors that may be local, regional or national in nature. For example, the availability of sufficient waste to justify the selection of complex and costly technologies may provide the required economy of scale necessary to make such facilities cost effective and sustainable. In addition, the availability and capacity of markets that may be available for outputs (materials, energy, etc.) from the technology application will have a significant impact on the economic and technical viability of individual technical choices. Development of regional investment plans (and the feasibility analyses that may accompany them) must closely consider the technical and economic viability of the various technology choices to assure that the investment results are capable of successfully meeting the objectives of the national strategy.

7. Treatment Options Assessment and Implementation Processes

Municipalities must select treatment approaches and technologies that are readily available, reliable, sensitive to waste composition changes that may occur in the future and that are not too technically complex or costly to implement and operate within the context of available technical capacity and economic resources. In selecting a treatment process, consideration must be given to the extent and stability of markets that exist for recovered outputs since the economic viability of treatment options may be dependent on the value of recovered output (such as the value of recyclables, compost and recovered energy). Municipalities must describe the manner and basis for the waste treatment that they will provide in the Municipal Waste Management Plans.

The following are the steps that should be taken to evaluate the viability of alternative treatment approaches:

1. The type and quantity of solid waste available locally or on a regional basis will determine whether a sufficient economy of scale is available to justify the use of certain technologies, particularly high capital cost technologies such as waste to energy thermal conversion processes.
2. A recovered resource only exists if there is a market outlet for the processing output. For example, a facility producing compost will only be successful if there is a viable outlet for use of the compost. This can be applied to other technologies that are intended to create a specific output.
3. Applicable national environmental legislation will determine the need for pollution abatement equipment as one of the major components of resource recovery facilities. For example, the use of incineration as a thermal processing approach will likely require complex expensive air pollution control equipment that may be as costly as the processing system itself.
4. A feasibility analysis related to the application of specific technology choices is necessary to determine the technical and economic viability of processing and treatment alternatives. The feasibility analysis should investigate all factors that are important in defining full lifecycle costs associated with the specific technology applications based on expected service life of facilities and its processing components. The feasibility analysis should include an attempt to define the means by which the subject technology can be financed and implemented. In addition, the feasibility analysis should also investigate the advantages and disadvantages of the various institutional frameworks by which the treatment project can be implemented and sustained.
5. In many countries, technology vendors have been quick to attempt to establish relationships with municipalities or regions and offer their products to them. However, given the complexity of planning, designing and operating such facilities, a thorough and transparent procurement process is necessary to assure that the appropriate systems are selected for implementation.

6.

7.

General Comparison of Technical Options

Technical Options	Economic Factors			Skill Requirement	Land Area Requirement	Economy of Scale Factors	
	Capital Cost	Recurrent Costs	Revenue Impact			Expected Project Setting	Minimum Project Scale
Recycling and Resource Recovery Options							
Materials Recycling	M	M	H	L	N/A	Local/Regional	None
Biological Conversion							
Aerobic – Compost	M	M	L	M	H	Local/Regional	100 TPD
Anaerobic – Biogas	H	H	H	H	L	Regional	300 TPD
Thermal Conversion							
Combustion	H	H	H	H	L	Regional	300 TPD
Gasification	H	H	H	H	L	Regional	300 TPD
Mechanical Conversion							
Refuse Derived Fuel	H	H	H	H	L	Regional	200 TPD
Sec. Recovered Fuel	H	H	H	H	L	Regional	200 TPD
Landfill Pretreatment Options							
Landfill w/ Preprocessing	H	H	N/A	M	M	Regional	300 TPD

Key:
H – High Impact
M – Moderate Impact
L – Low Impact
N/A – Not Applicable