



# SOLID WASTE COLLECTION AND TRANSPORT

## Service Delivery Training Module 1 of 4



MINISTRY OF LOCAL GOVERNMENT AND  
PROVINCIAL COUNCILS



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AND PROVINCIAL COUNCILS**





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## PREFACE

The Asia Foundation (TAF) implemented the Transparent Accountable Local Governance (TALG) Program with financial support from the United States Agency for International Development (USAID) from January 2005 - September 2007. The Foundation's main counterparts were the Ministry of Local Government and Provincial Councils and the Sri Lanka Institute of Local Governance. The International City/County Management Association (ICMA) and Environmental Management Lanka (EML) provided additional technical assistance and support.

The TALG Program developed a number of training modules and publications as part of its institutional strengthening programme for Local Authorities (LAs) in Sri Lanka. Each of the TALG training modules was used to train officials in thirty-five LAs in Southern, Eastern, Central, North Western, North Central and Uva provinces. These were very successful in promoting effective, transparent and accountable local governance. Preparing the training modules was a painstaking process and support from the Australian Agency for International Development (AusAID) enabled The Asia Foundation to complete and publish this and the other publications in the series.



## INTRODUCTION

Through the interventions made by the Foundation for the betterment of the Local Governance system in Sri Lanka, publications were developed in the following areas:

- Citizen Participation
- Local Planning
- Service Delivery
- Financial Management
- Policy and Regulations

These publications range from one-page documents of Leading Practices to Training Modules. Major categories of the publications are:

- Training Modules
- Guidebooks
- Reports and Documents
- Video Films
- Computer Applications

TALG developed many training modules mainly in the areas of Financial Management and Service Delivery. **Solid Waste Collection and Transport** is Module 1 under Service Delivery Training. Other training modules in the series include:

Module 2: Solid Waste Reduction

Module 3: Road and Drainage Maintenance

Module 4: Solid Waste Planning and Disposal

In addition to these training modules, TALG developed video films showing successful solid waste management (SWM) initiatives implemented by the Sri Lankan and regional LAs.

Users should note that there are a range of TALG publications including Technology of Participation and Resource Directory for Local Authorities that can be used by LAs to create an enabling environment for improved SWM.

### About this Training Module

#### Module 1: Solid Waste Collection and Transport

According to Sri Lankan legislation, LAs are legally responsible for providing SWM services. However, SWM has become a burning issue as most LAs do not have proper plans in place to execute this task effectively. In general, Sri Lankan LAs spend nearly 35-40% of their annual budget on SWM of which 60–70% is spent on waste collection and transportation. Despite this expenditure, many LAs do not satisfy their citizens' expectations for waste management services. This publication deals with the issues relating to Solid Waste Collection and Transport in LAs.



## What is Inside this Module

The publications developed by TALG can be used by different users, ranging from beginners to practitioners, those working in LAs and for those working as partners with LAs. This publication contains all of the resources developed for the delivery of a two-day workshop in Solid Waste Collection and Transport.

This training module provides comprehensive and detailed learning materials on Solid Waste Collection and Transport that can be used as reference material for practitioners in LAs and as background information for trainers. This module describes the tasks and logistics of SWM collection; analyzes collection systems; describes the principles and theory of transfer stations; and shows how to implement an efficient and cost effective collection and transport system for LAs. Interactive assignments and exercises have been included throughout the training module. Additional resources can be found at the end of the module, comprising of an action plan checklist, format for scheduling waste collection and guidelines on how to complete the 'Excel' spreadsheets.

Attached to this module is a CD which provides a 'PowerPoint' version of the learning materials with a focus on the needs of LAs. Also included is an 'MS Excel' spreadsheet application developed to help LAs measure and monitor their performance in waste collection and transport together with a guide for using this tool.

## The Main Objectives of this Module

- To provide guidance to LAs in Sri Lanka and officials who engage in SWM activities.
- To provide knowledge, skills and tools for planning LA waste collection and transport activities in a systematic manner.
- To assist LAs to deliver efficient and effective waste collection and transport services and to monitor and manage the workforce engaged in collection and transport.
- To assist LAs to ensure a satisfactory level of waste collection and transport operation to meet the needs and demands of citizens.

## How to Use this Module

The resources in this publication may be used:

- To enhance knowledge in this specific topic.
- To share the knowledge with others.
- To support a training programme and awareness campaigns.
- To improve the existing system and enhance performance monitoring.

Trainers and beginners can use these learning materials to obtain knowledge on present practices and issues of solid waste collection and transport in LAs. Learning materials will provide guidance to all decision-makers and staff who are involved in SWM activities. It will also provide guidance on how to reduce SWM costs within LAs.

Trainers can use the prepared 'PowerPoint' presentations to conduct awareness programmes for LA staff, decision-makers and other supporting staff. Group exercises can be used to improve practical experience of waste collection and transport.

User-friendly spreadsheets will help relevant officers to monitor daily activities on waste collection and transport. This can be used not only for monitoring but also for the decision-making process.

## SESSION 1: WHY SOLID WASTE COLLECTION IS REQUIRED

### Health of Citizens

Organic waste biodegrades quickly and releases pungent odours. The discharge of organic waste attracts flies, rats and other pests. These vectors spread diseases such as typhoid and cholera, and can also cause diarrhoea, eye problems, skin diseases etc. Improper disposal of solid waste leads to blocked drains, an increase in contaminated water bodies, an increase in the mosquito population and more diseases. All these will affect the health of the public by reducing life expectancy and increasing infant mortality. Better SWM, with improved waste collection, improves the health of all citizens.

### Environmental Sustainability

The water, air and physical environment have been affected due to bad management of solid waste. The contaminants with the solid waste and leachate from solid waste, pollute water bodies. The illegal burning of solid waste causes air pollution and health problems. All these threaten the sustainability of the environment. Better SWM through improved waste collection supports environmental sustainability.

### Beauty of the Area

Improper solid waste management, not only threatens the natural beauty of water bodies, forest reserves, diversity-rich mountains and beaches but also cities and villages. Littering spoils the scenic beauty of the environment. The major reason for aesthetic pollution is bad SWM. Better SWM through improved waste collection enhances the scenic beauty of the area.

### Economic Development

Cleaner cities are better able to attract private investments and tourists, and thus create more jobs in the locality. The inflow of investments brings economic prosperity and more revenue to the LA, hence satisfactory services to its citizens. Better SWM through improved waste collection facilitates economic development.

### Moreover....

#### Waste

- Everybody sees waste
- Every voter has waste

#### Waste Collection

- Most visible service
- More satisfaction, more votes

## Principles to Improve Solid Waste Collection and Transport

### Effective

For solid waste collection and transport to be effective, the LA must get the job done. Since a LA is vested with the responsibility of maintaining a disease-free environment for its citizens, it should ensure proper solid waste collection and transport. All the waste collected from households and other establishments should be emptied and disposed of through a socially and environmentally acceptable practice. Failures in waste collection leads to public health hazards.

### Efficient

Handle waste as few times as possible. It is a known fact that most LAs have inadequate and limited resources available to engage in the collection and transport of solid waste. The efficient use of resources by the LA in the collection and transport of solid waste shows how effectively the LA engages in this activity.

### Cost Effectiveness

Capital Investment Vs Labour Costs. SWM collection and transport makes up at least 60% of the total SWM costs. In most LAs, a large proportion of the annual budget is spent on SWM, mainly attributed to SWM staff costs. Therefore, it is essential to assess the efficiency of the service and develop ways to reduce costs and/or increase services within its current budget.

### Environmentally Appropriate

Efficient collection and transport of solid waste will provide citizens with a clean environment in which communicable diseases will be greatly reduced. All the waste collected from households and other establishments should be emptied and disposed of through a socially and environmentally acceptable practice.

### Citizen Involvement

The successful collection and transport of waste material, not only depends on the efficient operation of the LA, but also on the active involvement of citizens. The public must cooperate with the LA's requirements and the LA must provide an efficient service, particularly for collecting waste on time and according to schedule. The LA should also listen to the public for their ideas, respond to their requests and follow-up to resolve any complaints.

### Human Factors

LAs should ensure that trash is collected and litter cleared regularly. When trash and litter accumulates in the environment, it encourages people to add even more to the pile. If the environment is clean, people are discouraged from dumping trash and scattering litter.

### Teamwork

Most LAs are not organised in the same way as the private sector. LAs tend to have divisions like finance, operations and maintenance located in different places. In order to coordinate solid waste collection and transport there has to be an understanding of the work required, the impact on citizens as a result of delays and the ability to work as a team.

## General Issues in Collection and Transport

- Poor garbage storage/discharge. For example, garbage temporarily discharged at the roadside or in public bins must be re-loaded again by LA labourers into collection vehicles. Often, it takes around 20-25 minutes to transfer the contents of a full concrete bin into a tractor-trailer.
- Inappropriate waste transfer from handcarts to tractor-trailers. Typically, handcarts discharge their loads onto the ground, meaning it must be re-loaded into the trailer. This transfer process takes at least 5 minutes.
- Inappropriate waste transfer from hand tractors to four-wheel tractors. Garbage in two-wheel tractors must be emptied manually onto the ground, which takes around 20 minutes. This garbage must then be re-loaded into a trailer. It takes four labourers around one hour to fully load a 6m<sup>3</sup> trailer.
- Collection costs are high and service levels are low. As mentioned earlier, a major proportion of a LA's budget is spent on collection, whereas service typically covers only 30%-70% of the urban population and is often infrequent (less than once a week in the rural areas).
- Poor labour management and supervision.
- Inadequate cooperation from citizens with the LA's collection schedules and methods.
- Inappropriate type and size of collection vehicles.
- Non-rational routes for collection service.
- Failure to optimize vehicle productivity by selecting the appropriate crew size and shift duration.
- Inadequate container capacity at the communal collection points.
- Long vehicle down-times from poor equipment maintenance/repair.
- Long haulage times to disposal sites coupled with lack of transfer stations.
- Harsh driving conditions at disposal sites causing vehicle and tyre damage.

## SESSION 2: IDENTIFYING NEEDS, DEFINING CONSTRAINTS AND SETTING GOALS

### Principle

The needs of different stakeholders and constraints experienced by the service provider, are deciding factors in setting goals.

### Identify the Needs

- Be aware of and understand the needs of different stakeholders in this process, especially citizens, council and LA staff.
- Assess needs from the citizen perspective on waste collection (e.g. convenience, abatement of litter and accumulated waste). This could be carried out through consultations with citizen groups such as Ratepayers' Associations, Traders' Associations, Community Based Organizations, etc.
- Assess needs from the council and staff perspective (e.g. public health, environmental protection and cost efficiency).

### Define Constraints

- Constraints should be identified and incorporated into the decision-making process.
- Some constraints, such as funding, could possibly be adjusted to meet changing needs.

### Setting Goals

- Using citizen participatory methods of consultation, clearly define the goals for the solid waste collection system.
- Goals should be practical, achievable and measurable.
- Remember the needs and constraints.
- Periodically review the system's performance in meeting identified goals, and regularly review and adjust the system's goals to meet changes in citizens' needs.

## SESSION 3: CHARACTERIZE WASTE GENERATION AND SERVICE AREA

### Principle

Know who you serve and the nature of the waste.

### Classification of Service Area by Users (residential, commercial, government institutions, hospitals, industries, etc.)

- The Service Area is the geographical location in which the LA provides collection management services.
- By law, the geographical boundary of the LA should be the service area for SWM. However, in most cases, the LA serves only part of the area for SWM.

### Critical Information Required to Effectively Plan SWM

- Number of residential dwelling units and housing densities.
- Number of commercial establishments by type (restaurants, markets, etc.).
- Number of government/institutional buildings by type (schools, hospitals, etc.).
- Kilometres, width and condition of streets and roads, including primary, secondary and unimproved roads.
- Traffic patterns and transportation infrastructure.
- Land use patterns.

### Type of Waste Collected from Each Category in the Service Area

The potential types of waste that can be expected from each source within a Service Area are as follows:

**Residential:** Food waste, paper, cardboard, plastic, textiles, leather, garden waste, wood, glass, metal, ash, special waste (e.g. bulky items, consumer electronics, appliances, batteries, oil, tyres) and household hazardous waste.

**Industrial/Manufacturing:** Housekeeping waste, packaging, food waste, construction and fabrication waste, hazardous waste, sludge, liquid, ash, special waste and scrap material.

**Commercial:** Paper, cardboard, plastic, wood, food waste, glass, metal, special waste and hazardous waste.

**Medical:** Housekeeping waste, packaging, food waste, hazardous waste, infectious waste and radiological waste.

**Agricultural:** Spoiled food waste, crop waste, hazardous waste (e.g. pesticides) and food processing by-products.

**Construction/Demolition:** Wood, steel, concrete, bricks, brush, rocks, dirt and hazardous waste.

### Municipal Services

Street sweeping; landscape and tree trimming; general waste from parks, beaches and other recreational areas; water and wastewater treatment plant sludge waste.

### Hazardous Wastes

Household hazardous waste such as batteries, tube lights, spent drugs, oils, paints and chemicals and industrial hazardous waste.

## Services Provided

Collection and transport of solid waste normally includes some or all of the following activities:

- Residential waste collection.
- Commercial waste collection.
- Institutional (Government) waste collection.
- Industrial waste collection.
- Construction and demolition waste collection.
- Street sweeping and cleaning.
- Public facility (park, cemetery, etc) cleaning.
- Slaughterhouse waste.
- Waste transfer from collection points.

### Assignment 1:

Develop a Collection Database for your LA with the following information.

- Name of Road.
- Details of waste generators.

### Assignment 2:

Prepare a map for SWM purposes in your LA. Show the following information on the map.

- Present service area.
- Classification of waste generators.
- Future service area for expansion.

## Present Coverage and Future Expansion Possibilities

- Assess the coverage of the area within the LA purview with respect to collection of solid waste.
- Few LAs carry out collection services to all the types of users in a complete manner.
- Some provide collection services only to some users.
- Understand the future expansion possibilities.

## Service Standards

- There are different standards of service associated with quality, quantity and customer convenience issues.
- Service Standards usually include criteria for the frequency of the activity, the convenience of the service to the customer and some overall quality measures such as service reliability and thoroughness.

## Typical Service Standards

TYPE OF SERVICE	TYPICAL FREQUENCY MEASURES	TYPICAL SERVICE LEVEL OPTIONS
Residential Waste Collection	Daily, every other day, set days/week.	Door-to-door, building-to-building, waste pooling sites.
Commercial Waste Collection	Daily, every other day, set days/week.	Door-to-door, building-to-building.
Industrial Waste Collection	Daily, every other day, set days/week.	On-site pickup, regional collection centres.
Medical Waste Collection	Daily, every other day.	Site pickup in containers provided by medical waste service provider, delivery by producer to waste treatment facility.
Medical Waste Treatment	Continuous or on collection days.	Disinfection, sterilization, autoclaving, incineration.
Street Sweeping and Cleaning	Daily, set days per week.	Mechanical, manual, all streets, primary and secondary streets, litter baskets.
Public Facility Solid Waste Collection	Weekly, monthly, bi-monthly.	On-site pickup, litter bins and public bins.

## Special Events

The options identified for normal situations will not work during special situations.

- Uncollected accumulated waste – be aware of uncollected waste in the area, not only municipal solid waste but also other special types of waste such as medical and hazardous wastes.
- Seasonal variations (see below).
- Waste diversion systems – are there any organised or specialised recycling networks in place? Any market for recyclable matters?
- Implementing waste diversion systems help LAs to provide enhanced services with minimal extra resources.
- LAs may need additional manpower, collection vehicles and extended service hours during special events.

## Seasonal Variations

- Understand seasonal variations and anticipate the generation of above average amounts of waste.
- Understand the nature of extra ordinary situations in order to provide a better service during these periods.
- Some of these situations are Temple Festivals, Tourism Events and Agricultural Cultivations.



## **Present Disposal Methods**

The LA should have a clear idea on how they are going to dispose of the waste and should consider the following points.

- Present disposal sites.
- Expected life of the disposal sites.
- Cost of disposal.
- Issues related to present disposal systems.

## **Public Awareness and Education Programmes**

To have an efficient collection system, LAs should understand public awareness and educational programmes.

- Assess the existing programmes.
- Are they successful?
- Who are the stakeholders?
- How were the stakeholders included?

## SESSION 4: ASSESSMENT OF EXISTING CONDITIONS

### Principle

Understanding existing conditions is the first step to better planning.

Solid waste collection systems in most towns/cities in Sri Lanka requires LAs to collect waste from wherever it is discarded, including roadside, drains, public bins, etc.

LAs need to document:

- Storage/handling practices (types of containers and wastes).
- Collection Service Methods (Point of Collection and Method of Collection).
- Frequency of collection.
- Service Standards.
- Special Considerations (accumulated waste, waste diversion systems, special occasions).
- Present disposal methods.
- Public awareness and education programmes.
- Use of Transfer Stations.

### Service Area Map

- A Service Area Map is a useful management tool for SWM.
- Should give all relevant information about SWM activities performed by the LA.
- Should show the entire boundary of the Service Area.
- Should include the different land use patterns within the LA area.

### Important Land Use Classifications in SWM Planning Include:

- Residential (high, medium or low density).
- Commercial (shopping complexes, slaughterhouses, etc.).
- Industrial (light, medium, heavy).
- Governmental.
- Institutional.
- Medical.
- Public facilities (markets, airports, bus and rail stations, parks, etc.).
- Tourist areas including areas of antiquity e.g. Cultural Triangle.
- Agricultural.
- Open space.

City Street and Block Maps should be obtained to determine specific configurations, number of houses, location of one-way and dead-end streets and traffic patterns.

**Assignment 3:**

Update the Collection Database for your LA with the following information.

- Storage and handling.
- Collection service methods.
- Collection frequency.

**Assignment 4:**

Update the Service Area Map for SWM purposes in your LA with the above information.

## SESSION 5: OPTIONS FOR IMPROVING COLLECTION

### Principle

One size will not fit everybody. The service has to be tailored to meet the needs of different users.

### Evaluation of Points of Collection

#### Important Points to Consider

- Type of waste to be collected.
- Type of service user.
- Ease of accessibility.
- Constraints.

### Points of Collection Options

#### Door-to-Door

- Involves the LA labourers entering the premises, collecting garbage from a storage area and emptying it into the collection vehicle.

#### Building-to-Building

- Collecting garbage from outside/adjacent to buildings, along streets or alleyways.

#### Bell Collection

- Music based collection method, where garbage collection vehicles play special music or callers shout "dustbin" as they collect garbage.

#### Kerbside Collection

- Closed containers placed on roadside for collection.
- Containers are returned to pickup point after emptying.

#### Handcart Collection

- Handcart collection is a type of a kerbside collection system.
- Labourers collect waste stored in containers, bags of waste left at the kerbside or collect waste directly from the resident.
- Handcarts must transfer their loads to a tractor, lorry or compactor for transportation to the disposal site.
- In areas of the town/city that have narrow or congested roads, handcarts are often used for collection.

#### Waste Pooling Sites

- A centralized collection point typically located on public property no more than a specified distance from any waste generator.

- Some of the common methods used in waste pooling sites in Sri Lanka are,
  - Public Bin Collection
  - Stationery Trailer Collection
  - Dumpster Collection
  - Public Litter Baskets/Bins

### **Public Bin Collection**

- Involves people carrying their garbage to a public concrete bin.
- The garbage should be discharged into the bin in a closed disposable container (e.g. plastic bag).

### **Stationary Trailer Collection**

- Similar to the public bin collection system, except that in this case, a stationary trailer is parked at a particular location on specified collection day(s) and/or times.
- People are required to discharge their waste into the trailer.
- LA will subsequently come and remove the trailer for emptying.

### **Dumpster Collection**

- Similar to stationary trailer but smaller in size.
- Used to transfer waste hydraulically or by means of forklift to the collection vehicle.

### **Public Litter Baskets/Bins**

- “Mini” version of waste pooling sites.
- Helps to reduce waste scattering and collection, street sweeping and drain cleaning workload.
- For litter – e.g. lunch packet leftovers, lottery tickets, food packaging, etc. – not for garbage.

## Compatibility of Points of Collection Options

Factors to be Considered	Door to Door	Adjacent to the Building	Waste Pooling Sites
Cost Effectiveness	Highest cost. Most beneficial.	Moderate cost.	Lowest cost. Least convenient to service users.
Health and Safety	Most injuries to service crews as a result of carrying and climbing stairs with a load.	Manual labour and injury risk reduced, especially with use of handcarts.	When compared to collection at buildings, waste pooling sites can be dangerous to service users and crews, particularly if the sites are not properly designed.
Environmental Appropriateness	Most environmentally sound. Controls waste at the source. No waste litter.	Environmentally sound, but if service is not frequent, some litter may remain around containers.	Potential for waste overflow, littering, insects, birds, rodents and communicable diseases.
Effectiveness	Effective if residents follow rules i.e. must put waste outside door within restricted hours.	Very effective if handcarts used. Waste can be put out at residents' convenience.	Very effective if collection is properly scheduled.
Public Acceptance	Very high. Most convenient for public.	Moderate convenience.	Not very convenient. Residents complain in having to walk to the site, aesthetics of site, pests and odours.
Efficiency	Not efficient from productivity standpoint. Requires the most labour and equipment resources.	Very efficient, reduces labour and vehicle requirements.	Low cost. Most efficient. Depends on collection frequency and citizen practice.

## Evaluation of Waste Collection Options

It may not always be possible to accommodate all the different types of waste generated by residents and businesses within the conventional waste collection system. Some of these wastes may require separate or different collection methods.

### Important Points to Consider

- Quantity of waste.
- Density of waste.
- Composition of waste.
- Possibility of revenue generation.
- Constraints.

### Market Waste

- Mainly organic waste, which consists of fruits and vegetables.
- Market traders should be required to keep their own dustbins into which they discharge their waste.

### Street Sweeping and Drain Cleaning

- If street sweepings are left in small piles along the roadside waiting for collection, they will be scattered within a relatively short time. Sweeping must then be repeated.
- Street sweeping waste should be directly loaded into a handcart or other collection vehicle.
- Drain cleanings are often left for long periods at the roadside following removal, again resulting in waste scattering or the waste being washed back into the drain when it rains.

### Roadside Vegetation and Trimmings

- The vegetation and trimmings cut along the roads under the purview of the LA needs to be collected by the LA itself.
- This type of waste is significant during the rainy season.

### Healthcare Waste

- Healthcare waste includes significant quantities of hazardous materials, including sharp objects, infectious material and some contaminated plastic waste.
- All LAs should be aware of the National Healthcare Waste Policy, which sets out requirements for packaging, treating and disposing of different categories of healthcare waste.
- Often, healthcare waste is disposed of by open burning and/or pit burial within the premises of the medical institution. Alternatively, they may be put out for collection with normal garbage. However, even in the instances where the medical institution disposes of healthcare waste on site, due to poor waste segregation, some sharp objects and clinical waste are still present in normal garbage.
- Healthcare waste should be identified and segregated as close as possible to the source. They should be sorted into containers or plastic bags coded with the international two-colour (black and yellow) system. This will prevent or minimise contamination of the hospital and wider environment.

The Ministry of Health has prepared a draft National Policy on Healthcare Waste Management for Sri Lanka (October 2001). This policy divides healthcare waste into three categories, as summarised below.

## Categories of Healthcare Waste

### Draft National Policy on Healthcare Waste Management for Sri Lanka (October 2001)

Category	Description	Examples
Non-risk (75-90%) (Class 1)	All waste that has not been contaminated with potentially infectious agents or toxic products (similar to municipal waste).	Kitchen waste, coconut shells, packaging material, plastic/metal storage containers, saline bottles.
Hazardous (10-25%) (Classes 2 and 5)	All waste that has been contaminated with potentially infectious agents or toxic products.	General: Laboratory cultures, waste from isolation wards, human tissue, equipment that has been in contact with infected patients. Anatomical: Body parts, placentas. Pathological: Blood, human fluids. Chemicals, heavy metals and pressurised containers, laboratory reagents, solvents, broken mercury thermometers. Pharmaceutical: Expired drugs, bottles contaminated with drugs.
Highly Hazardous (<5%) (Classes 2,3,4 and 5)	Sharps. Highly infectious waste. Genotoxic waste. Radioactive waste.	Scalpels, needles, blades, infusion sets, broken glass. Microbial cultures. Mitotic inhibitors, alkylating agents. Urine and excreta from in-patients treated with radionuclides, contaminated glassware.

The National Policy states:

- Every hospital is legally responsible for the proper management of the waste that it generates until its final disposal in accordance with the National Environmental Act No47 (1980) and National Environmental (Amendment) Act No53 (2000).
- Major hospitals should set up internal healthcare waste management plans, while all medical institutions are encouraged to do the same.
- Healthcare waste generation should be minimised as much as possible.



- Healthcare waste should be identified and segregated as close as possible to the source and sorted into containers or plastic bags coded with the international two-colour (black and yellow) system (see following Table). Note that the Ministry of Health and Indigenous Medicine has also introduced a more complex colour code system based on nine colours, which is on trial at the Castle Street Hospital for Women, Colombo. The two-colour (yellow and black) system is considered the **minimum** standard that medical institutions should adopt, being both practical and affordable. Some hospitals may choose to follow a more complex colour code system of up to nine colours according to the scale of their operations and financial resources.

### Classification, Packaging, Treatment and Disposal of Healthcare Wastes

Class	Colour Code	Healthcare Waste (HCW) Type	Packaging	Treatment/Disposal
1	Black	Non-risk HCW.	200 micro bags.	With municipal waste.
		Non-contaminated plastic/glassware.	Adequate container.	Disinfection or sterilisation and recycling.
2	Yellow	Infectious and highly infectious HCW.	300 micro bags.	Major hospitals: disinfection, incineration, autoclaving and shredding. Minor medical institutions: incineration or safe burial.
		Pathological HCW.	300 micro bags.	Incineration or safe burial.
		Anatomical HCW.	300 micro bags.	Incineration or safe burial.
		Small quantities of pharmaceutical and chemical HCW.	300 micro bags.	Incineration, encapsulation or rendering inert.
3	Yellow	Sharps.	Safety boxes.	Dispose as for infectious HCW.
4	Yellow	Radioactive HCW.	Specific containers.	Storage and disposal as for class 1 or 2.
5	Yellow	Large quantities of pharmaceutical and chemical HCW.	Specific containers.	Return to supplier, encapsulation or rendering inert.
		HCW with high content of heavy metals.	Specific containers.	Return to supplier or encapsulation.
		Effluents.	-	Specific treatment.

### Evaluation of Types of Storage Containers

#### Important Points to Consider

- Point of collection.
- Types of waste.

- Environmental appropriateness.
- Design.
- Maintenance.

Several types of containers may be suitable for storage of waste, but in some cases the selection is dictated by the method or point of collection.

### **Metal or Rigid Plastic Containers**

If the point of collection is outside the building, the institution should only use rigid plastic/metal containers with tight fitting lids that are specifically manufactured to hold waste.

#### **Bins**

In general, bins are commonly used for the storage of solid waste prior to the waste being collected or transported to a disposal site or transfer station. Public waste bins, litterbins and moveable waste bins fall under this category.

#### **Public Bins**

- This system is suitable for densely populated areas and/or where handcart/vehicle access is difficult.
- Public garbage bins are often difficult to empty, taking around 20-25 minutes or longer to transfer the garbage from the bin to the collection vehicle.
- Public bins are very difficult to keep clean and can quickly turn into mini-dumps, annoying nearby residents.
- The LA should consider the necessity for public garbage bins on an individual basis and try to reduce the number of bins wherever possible. The successful implementation of this depends heavily upon periodic scheduling of removal.
- Public garbage bins may be useful in areas where there are housing schemes or at junctions where several small inaccessible byroads meet.
- Where bins are needed, it is recommended that enclosed bins be installed. These are like a box, with access steps leading to the hatch on the top for dumping waste and an elevated side door for easy emptying.
- Another method is to place a moveable bin inside the actual bin. The moveable bin can be directly transferred to the collection vehicle, making loading easy.

#### **Stationary Trailer**

- The trailer should be covered to reduce waste scattering whilst stationary and during transportation.
- Suitable for densely populated and/or congested areas, including commercial areas, markets, etc. and for the transfer of handcart waste.
- There are closed and open trailers used for storage, but closed types are preferred for the following reasons:
  - Prevents waste scattering.
  - Denies access to animals.
  - Controls odour.
  - Gives a pleasant aesthetic view.

### Litterbins

- Litterbins should be small/medium sized to prevent people discharging their household garbage into them, causing the bin to overflow and litter to scatter.
- Size of the bin/basket and distance between them depends on how busy the location is. For example, Kandy Lake surrounds may require 40L bins at 25m intervals near the bus stand and Temple of the Sacred Tooth Relic, while 25L bins at 25m intervals may suffice for other parts of the Lake. The bins/baskets must also be emptied often.
- Too many baskets will increase the collection work. The LA should assess whether small or large bins/baskets are required in the various locations.

### Compatibility of Types of Storage Containers and Handling

Factors to be Considered	Manual	Semi-Automated	Automated	Bins
Cost Effectiveness	Most cost effective. Minimum cost. Makes manual collection easy.	Moderate cost for container. Makes collection more difficult for manual labour.	Cost effective under right conditions. Carts last 10 years and reduce collection costs.	Cost effective as collection work is minimized. Bins last many years with proper maintenance.
Health and Safety	Risk of injury to collectors from sharps in bags.	Potential for back injury if container is overloaded. Repetitive lifting reduces worker longevity.	No lifting or exposure to waste. Minimal risk of injury to user or service provider.	Potential health and safety risk to users and collection workers due to high possibility of waste scattering.
Environmental Appropriateness	Uses more natural resources. Potential source of litter.	Environmentally sound. Container use reduces litter potential. Reusing container saves resources.	Environmentally sound. Cart life saves resources. Proper use eliminates litter.	Can be environmentally sound. High potential for overflow and negative impacts on the environment if not properly covered or serviced.
Effectiveness	Effective. Easy for user and collector to handle.	Very effective. Produces the desired positive effect of controlling waste at the source.	Very effective and convenient. Controls waste and reduces environmental impact.	Moderately effective. If properly designed, can be more effective.
Public Acceptance	Very high. Most convenient for public.	Not high acceptance as the public are used to using plastic bags.	No experience, since no application here.	Poor public acceptance as there are negative impacts such as odours, inconvenience, unsightly areas and pests.

Efficiency	Very efficient for user and collector.	Somewhat efficient. Moderately effective at a reasonable cost.	Highly efficient. Efficient to use and mechanical dumping increases collection productivity.	Very efficient. Moderate cost.
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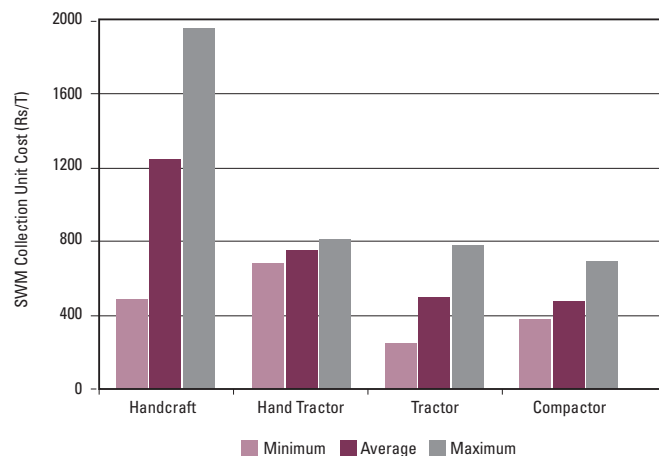
## Evaluation of Methods of Collection

Methods to collect residential and commercial solid waste from any point of collection falls into one of the following categories:

- Manual collection.
- Semi-automated collection.
- Automated collection.

## Handcart Collection

- Generally, handcart collection is undertaken as primary collection only. Loads must be transferred to a stationary trailer or collection vehicle for transportation to the final disposal site. This is preferable to handcarts emptying their loads into public bins or other community collection points.
- Garbage should be loaded into handcarts in disposable bags, so that these may be easily transferred to transportation vehicles. Alternatively, garbage can be loosely placed into six to eight 30-40 litre buckets within the handcart (a 'bin cart'), which can subsequently be lifted out and emptied one by one. There should be a liner within handcarts so that loosely placed garbage can be easily lifted into a transfer vehicle. It is also useful to place a liner in 'bin carts' to catch any overspill waste from the bins.
- Handcart collection is suitable for sweeping street waste and is not appropriate for collecting bulky garbage.
- Handcarts can be used for collecting drain cleanings. However, the buckets should not be completely filled or else they will be too heavy for one person to lift.
- Handcart collection is very expensive compared to other forms of collection (refer to graph below). This is mainly due to the high labour costs (2-3 workers per handcart) and the low tonnage carried per load (around 120kg).



SWM Collection/Transportation Unit Costs in Selected Seven Towns (JICA mid-2002)

- Handcart collection is useful and/or necessary in some locations – narrow roads, congested areas, markets, common bins, etc.
- It is vital to restrict handcart usage to only essential places in order to reduce overall costs.

### Hand Tractor Collection

- Hand tractor collection is moderately expensive.
- Hand tractors have a number of other disadvantages:
  - They must be unloaded manually, which takes at least 20 minutes per load.
  - They are poor at reversing, especially up slopes and under soft, wet conditions (e.g. at disposal sites).
  - They are very slow and hold up traffic.
- Hand tractor usage should be restricted to narrow roads in residential areas that cannot be accessed by other motorised vehicles.

### Tractor/Trailer Collection

- Tractor/trailers are the most common type of collection vehicle currently used in Sri Lanka.
- They cannot be used in some narrow, congested areas.

## Evaluation of Collection Frequency Options

### Important Points to Consider

- Storage capacity.
- Financial capability.
- Customer satisfaction.
- Constraints.

Selection of the appropriate collection frequency must take into account storage capacity requirements, available storage space, as well as the selected design goals.

Collection frequency is usually decided based on the financial capability of the LA, rather than the needs of the customer. The table below compares the service frequency options with typical design goals.

### Compatibility of Collection Frequency Options

Factors to be Considered	Daily	Two Times a Week	Three Times a Week
Cost Effectiveness	Cost is high due to the requirement for increased labour and transport capacity.	Least labour cost, but greater transport capacity needed depending on use of transfer stations.	Less labour cost, but more transport capacity needed.
Health and Safety	Minimal health risks.	Longer storage time at generation location increases public and worker health risks.	No obvious health/safety risks.

Environmental Appropriateness	Greatest use of fuel and other resources.	Uses least natural resources. More illegal dumping and litter likely if personal storage capacity is limited.	Less resource use than daily collection.
Effectiveness	Most effective as waste can be set out for collection and be removed every day.	May not be effective if residents forget collection days. May result in litter and illegal dumping if personal storage capacity is limited.	Difficult to schedule regular collection, unless crews work 6 days per week.
Public Acceptance	High level of convenience.	Low. Residents may be reluctant to store waste if there is no outside storage facility.	Medium level of acceptance.
Efficiency	Not efficient as excessive resources are required to collect small amounts of waste.	Efficient for collectors but reduces service level for customers.	Somewhat efficient. Moderately effective at a reasonable cost.

### How to Decide the Most Suitable Option

There will be trade-offs in deciding the most suitable option.

- **Customer/Citizen Requirements** – the needs of citizens should be considered when selecting the most suitable option. Public consultation is necessary to balance costs and service levels.
- **Different Service Users** – Different levels of service will be required for different types of users.
- **Types of Waste Material** – Different types of users produce dissimilar waste and suitable options will have to be provided to meet their needs.
- **Available Resources** – Existing LA resources, both physical and financial, will heavily influence the final decision.
- **Cost** – In the Sri Lankan context, cost is the main deciding factor.
- **Environmentally Suitable** – Environmental considerations should influence the decision, even if it is more costly.
- **Constraints** – It is obvious that the LA should identify its constraints before finalising any options. Discussing issues and options with citizens is critical to success.

#### Assignment 5:

Evaluate your current system with the help of the database and map you have developed, and identify possible changes to the system in the following areas:

- Storage and Handling
- Collection Service Methods
- Collection Frequency

## SESSION 6: SCHEDULING AND ROUTING

### Principle

- To receive a satisfactory service, citizens should be aware of the collection schedule. It is important to provide a regular schedule each week.
- Minimise back tracking and dead headings in collection i.e. spend more time on collection.

Detailed route configurations and collection schedules should be developed for the selected collection system. Efficient routing and rerouting of solid waste collection vehicles can decrease labour, equipment and fuel costs, and increase customer satisfaction by making pick-up predictable. The size of each route depends on:

- The amount of waste collected per stop.
- Distance between stops.
- Loading time.
- Traffic conditions.
- Method of collection.

In addition, physical barriers such as railroad embankments, rivers and roads with heavy competing traffic, can be used to divide route territories. As far as possible, the size and shape of route areas should be balanced within the limits imposed by such barriers.

### Innovative / Good Practices

- The successful performance in collection and transport by some LAs should be studied and analysed for replication in other Sri Lankan LAs.
- Nuwara Eliya Municipal Council (NEMC) successfully engages in SWM activities through efficient and effective collection and transport of waste materials. Also, personnel management and performance monitoring practices followed by NEMC should be shared with others for possible replication.
- Hatton – Dickoya Urban Council successfully engages the private sector in collection and transport of waste material from part of the city. The lessons learnt should be shared with other LAs planning to use the private sector.
- Trishaw collections in India – trishaws have been used in India for solid waste collection and they have been found to be an efficient replacement for handcart collection.
- Bags – use of biodegradable bags for collection purposes reduces handling and scattering of litter.
- Roller carts – comparatively fewer issues in handling and transferring waste to collection vehicle than normal bins.

## Rules for Routing

1. Routes should not be fragmented or overlapping. Each route should be compact, consisting of street segments clustered in the same geographical area.
2. The collection route should start as close to the garage or motor pool as possible, taking into account heavily travelled and one-way streets (see rules 3 and 4).
3. Collection from heavily travelled streets should not be carried out during rush hours.
4. In the case of one-way streets, it is best to start the route near the upstream end of the street, working down it through the looping process.
5. Services on dead-end streets can be considered as services on the street segment that they intersect, since they can only be collected by passing down that street segment. To keep right turns to a minimum, collect the dead-end streets when they are to the left of the truck. Collections from dead-end streets must be made by walking down, backing down or making a u-turn at the dead-end.
6. When practical, solid waste on a steep hill should be collected on both sides of the street while the vehicle is moving downhill. This facilitates safety, ease and speed of collection. It also lessens wear of the vehicle and conserves gas and oil.
7. Higher elevations should be at the start of the route.
8. For collection from one side of the street at a time, it is generally best to route with many counter-clockwise turns around blocks. Note: Heuristic rules 8 and 9 emphasize the development of a series of counter-clockwise loops in order to minimize right turns, which generally are more difficult and time-consuming than left turns. Particularly for left-hand-drive vehicles, left turns are safer.
9. For collection from both sides of the street at the same time, it is generally best to route with long, straight paths across the street before looping counter clockwise.
10. For certain block configurations within the route, specific routing patterns should be applied that best fit the layout.

### Assignment 6:

Develop a feasible routing and a schedule for the collection of waste material, using the available service area map.



## SESSION 7: EVALUATION OF OPTIONS FOR TRANSFER MECHANISM

### Principle

- When disposal sites are close by, this reduces or eliminates the need for transfer stations.

Transfer is beneficial when the combined costs of hauling from the route to the transfer station and then to its final destination is less than the cost to haul waste directly from the collection route to the processing or disposal facility.

Transfer and transportation systems vary significantly among transfer stations, but they all consist of the following components:

- A site near waste collection routes.
- A receiving area where waste collection vehicles discharge their loads.
- Equipment to move waste from the receiving area and load it into larger vehicles.
- Transportation equipment, typically a semi-tractor and transfer trailer, to take waste from the transfer station to the processing or disposal facility.
- Equipment to unload waste from transport vehicles (if not self-unloading) at the processing or disposal facility.

### Siting Criteria

- Siting criteria must be developed before identifying potential transfer station sites.
- Three categories or sets of criteria applied during various stages of the siting process are exclusionary, technical and community-specific criteria.
- Sites may not meet all the criteria, in which case, each criterion's relative weight and importance must be considered.

### Exclusionary Siting Criterion

Exclusionary criteria might include areas such as:

- Wetlands and floodplains.
- Endangered and protected flora and fauna habitats.
- Protected sites of historical, archaeological or cultural significance.
- Prime agricultural land.
- Coastal habitats.

### Technical Siting Criterion

Developing the technical siting criterion includes technical parameters that help define facility sites with the best potential. These parameters provide guidance on specific engineering, operation and transportation conditions that should be considered to ensure that potential sites are feasible from a technical, environmental and economic perspective. They address the following issues:

- **Central location to collection routes:** To maximize waste collection efficiency, transfer stations should be located centrally to waste collection routes.
- **Access to major transportation routes:** The transfer station should have direct and convenient access to vehicles that bring collected waste.

- **Site size requirements:** The area required for transfer stations varies significantly, depending on the volume of waste to be transferred, rates at which waste will be delivered, the functions to be carried out at the site and the types of customers the facility is intended to serve.
- **Traffic compatibility:** Consideration must be given to the surges in traffic at transfer stations when collection vehicles have finished their routes.
- **Ability for expansion:** When selecting a site, consider the potential for subsequent increase in the daily tonnage of waste the facility will be required to manage, or the added processing capabilities for recycling and diversion.
- **Buffer space:** To mitigate impact on the surrounding community, a transfer station should be located in an area that provides separation from sensitive adjoining land uses such as residential homes.
- **Gently sloping topography:** Sites with moderately sloping terrain can use topography to their advantage, allowing access to the upper levels from the higher parts of the natural terrain and access to lower levels from the lower parts.

### Community-Specific Criterion

The community-specific criterion considers the impact the facility will have on the surrounding community. These are typically less technical in nature and incorporate local, social and cultural factors. Examples include:

- Environmental justice considerations (limiting clustering or cumulative impacts by many adverse users).
- Impact on air quality.
- Impact on the local infrastructure.
- Adjacent land uses, including other environmental stressors that might already exist.
- Proximity to schools, churches, recreation sites and residential homes.

## SESSION 8: ESTIMATION OF COST FOR COLLECTION AND TRANSPORT

### Why Financial Management is Essential in SWM

- To identify actual cost spent on SWM activities.
- To explore cost saving possibilities.
- For performance monitoring.
- To consider private sector involvement.

When looking at Sri Lankan SWM costs, it is useful to consider the following:

- Currently, for most LAs the processing/treatment cost is zero (i.e. there are no centralized composting or recycling facilities).
- Similarly, most LAs do not have transfer stations. Hence, this cost is usually zero. However, by providing transfer stations the LA may be able to increase service and/or reduce costs.
- Most LAs are not spending enough money on the final disposal of waste. Spending on the final disposal needs to be increased as LAs progress from open dumping to other more environmentally sustainable methods of disposal.
- Typically, SWM collection/transportation makes up more than 60% of the total SWM costs.
- Generally, in Sri Lanka, SWM costs are somewhat low compared to developed countries as these countries use transfer stations and set a high standard for the disposal of waste.

In order to track the operational and maintenance cost for collection and transport, a simple methodology can be used.

1. Collect cost data.
2. Collect operational data.
3. Analyse data.
4. Report and follow-up.

### Cost Data

For the following reasons, most LAs find it very difficult to calculate SWM unit costs:

- Almost all LAs in Sri Lanka do not record SWM expenditure in a way that allows them to calculate unit costs. Instead, the current LA accounting system may, at best, allow the following SWM costs to be determined:
  - Total salaries
  - Office equipment/expenses
  - Vehicles
  - Disposal
  - Other
- Many LAs do not keep accurate records of the amounts of garbage they are collecting/disposing. SWM tonnages/volumes are either not known or must be estimated from approximate vehicle trips.
- Operating costs are recurring costs or expenses of doing business. There are generally two principal operating costs, operations and maintenance (O&M) and debt service (interest only loans).

- Costs for resources with useful lives in excess of 1 year are commonly called capital costs.
- Capital cost assets - The majority of assets in a SWM system are usually comprised of vehicles, equipment, land and facilities.
- The assets will be depreciated, and each year’s depreciation will constitute the asset’s cost for that year.
- An inventory of all capital cost assets must be established and maintained so that costs related to the use of these resources can be allocated properly.
- Annual costs for SWM should be determined for each category and divided by an appropriate tonnage of waste in each case to obtain the category unit cost.
- These annual and unit costs are very useful for planning purposes, particularly when looking at ways to reduce SWM costs.

### List of Operating Cost Items (Sri Lanka)

Category	Items
Collection:	Driver and labourer salaries.
• Handcarts	Staff equipment (gloves, aprons, boots, etc.).
• Hand Tractors	Diesel/oil.
• Tractors/Trailers	Vehicle repair/maintenance.
• Lorries	Trailer repair/maintenance (including periodic frame rebuilding).
• Compactor Trucks	Periodic handcart frame rebuilding (some LAs only).
	Tyres.
	Insurance/License.
	Depreciation.
	Overheads.
Transfer Station	All staff salaries – supervisor, vehicle drivers, labourers.
	Staff equipment.
	Tractor wheel loader costs.
	Transfer vehicle costs.
	Chemicals for odour/pest control.
	Land rental.
	Security.
	Overheads.

### Operational Data

Customer service area and collection cost data refers to the following:

- Details about customers such as demographics, units serviced, neighbourhood growth rates, waste collected etc.
- Once the data is collected and updated, the LA will have a wealth of operational and demographic information. For example, it will be able to estimate future waste volumes based on predicted population growth and correlate waste production against household income to efficiently allocate service vehicles and plan capital expenditure.

All of the collected data can then be used to further refine operational factors for the SWM department. The list below shows various indicators that can be produced:

- Crew size per collection vehicle, by neighbourhood.
- Vehicles needed per number of residences and/or shops, by neighbourhood.
- Fuel cost per vehicle per year.
- Maintenance costs per vehicle per year.
- Fuel and maintenance costs per vehicle hour of operation.
- Labourers per km of street for manual street sweeping.

### Data Analysis

- Prepare sound budgets that stand up to scrutiny and questioning.
- Pinpoint inefficiencies or other problems in the collection and transport process.
- Compare financial results/ratios with those of other countries or against other LAs.
- Good financial analysis is only possible with good financial accounting.
- The results of financial analysis serves as a tool to improve efficiency, eliminate waste, improve service to citizens and lower costs.

The following table shows how SWM O&M collection/transportation costs can be calculated for a tractor/trailer unit, using typical Sri Lankan data (2003).

### Example of Calculating Tractor/Trailer O&M Collection/Transportation Costs

Item	Units	Unit Rate	Quantity	Cost
Driver	Rs/month	7,189	1 x 12	86,264
Labourers	Rs/month	6,860	3 x 12	246,960
Staff equipment	Rs/year	2,500	1	2,500
Diesel	Rs/month	4,500	12	54,000
Oil	Rs/month	300	12	3,600
Tractor repair/maintenance	Rs/month	2,000	12	24,000
Tyres	Rs/year	9,333	1	9,333
Trailer repair/maintenance	Rs/year	20,000	1	20,000
Insurance	Rs/year	7,800	1	7,800
License	Rs/year	150	1	150
Depreciation	Rs/year	73,333	1	73,333
<b>Total</b>				<b>527,940</b>
Average trips	Trips/day			2.1
Average Tonnage	Tonnes/year			895
<b>Unit cost</b>	Rs/Tonne/year			<b>590</b>

#### Notes:

1. Average trips per day = Total number of tractor trips/number of tractors
2. Average tonnage per year = Average trips/day x 365days/yr x No. of tonnes/trip. No. of tonnes per trip should ideally be measured by a weighbridge. Alternatively, it may be calculated from the average tractor filled volume x garbage bulk density (typically 300-400kg/m<sup>3</sup> in Sri Lanka).

## Report and Follow-up

- Financial analysis of collection and transport of waste materials only makes sense when the results are translated into meaningful reporting practices.
- Technical staff should explain the situation in terms of rupees and cents to the decision-makers, especially the political leadership of the LA and citizens.
- To assist LA staff that engage in SWM activities, a simple worksheet has been produced, which allows staff to develop standard reports on financial analysis in collection and transport.
- A cost report worksheet will have the following information, along with monthly comparisons:
  - Total salary of permanent employees per month.
  - Total salary of casual employees per month.
  - Total overtime payment made per month.
  - Total collection cost per month.
  - Total collection cost per tonne of SW.
  - Total vehicle cost per month.

The LA should compare its SWM O&M collection/transportation costs for the different types of vehicles it operates with the unit costs shown above. 'Good performance' should be no greater than the average values shown and ideally less than this, while unit costs as low as Rs250/tonne may be possible for four wheel tractors and compactors. It should then look at ways of reducing high costs. Some important questions to consider include:

- Where is handcart garbage collection necessary and where can it be eliminated?
- Where is hand tractor collection necessary and where can it be eliminated? Ideally, hand tractor usage should gradually be phased out from non-essential areas.
- How can waste scattering and the garbage loading time be reduced?
- How many trips should each vehicle be able to make each day? How many vehicles actually achieve this?
- How many labourers should be assigned to each collection vehicle?
- How often should garbage be collected from different areas? Where is daily collection necessary? Where can longer collection frequencies be used?
- Are the trailers being used at least 6m<sup>3</sup> in size? If not, can their capacity be increased?
- How much of the trailer capacity is being filled with garbage per trip? If less than 80%, is this due to poor design? If so, can the trailer capacity be increased by modifying it at a reasonable cost? If not, can the collection route or frequency be modified to ensure the trailer is more than 80% full when it travels to the disposal site?
- Should labourers' working hours be modified to avoid peak traffic times?
- How can stationary trailers be used to reduce collection/transportation costs?
- How much working time is lost due to labourer absenteeism and/or driver absenteeism?
- Would privatisation save the LA money?
- What proportion of labourers' salaries does the LA pay out as overtime? Is this cost effective?
- Could overtime payments be reduced?

### Assignment 7:

Identify, collect and process cost-related data and prepare financial reports using the guidelines given.

## SESSION 9: PERSONNEL MANAGEMENT

Crew size can have a great effect on overall collection costs. With the rise in collection costs, there has been a trend towards:

- Decreasing frequency of collection.
- Increasing requirements on residents to sort materials and transport them to the curb.
- Increasing the degree of automation used in collection.

These three factors have resulted in smaller crews in recent years.

### Training

LAs should:

- Develop a training programme for employees to help them improve and broaden the range of their job-related skills.
- Address health and safety concerns.
- Provide team-building sessions and make sure employees are aware of their roles and responsibilities.
- Address such subjects as driving skills, first aid, safe lifting methods, identification of household hazardous wastes, avoidance of substance abuse and stress management.

### Health and Safety

Collection personnel frequently encounter the following hazards:

- Busy roads and heavy traffic.
- Rough and sharp-edged containers that can cause cuts and infections.
- Exposure to injury from powerful loading machinery.
- Heavy containers that can cause back injuries.
- Dangers from discarded household hazardous wastes such as herbicides, pesticides, solvents, fuels, batteries and swimming pool chemicals.
- Dangers from improperly disposed of medical waste.

To minimize injuries, LAs should have an ongoing safety programme. The safety programme should include, at a minimum, the following items:

- Procedures and training in proper lifting methods, material handling, equipment operation and safe driving practices.
- A record keeping and reporting procedure for accidents.
- Requirements for protective clothing such as hard hats, gloves, goggles, safety shoes, high-visibility vests etc.
- Frequent refresher sessions to remind workers of safe working habits and department requirements.

### Fleet Management

- LAs should have a record of all vehicles and equipment used in the collection and transportation of waste.
- Inadequate maintenance of waste collection vehicles has been a root cause for failure in the collection service.

- Even new vehicles require continuous preventative maintenance in order to function in a safe and operable condition over the expected useful life of the vehicle.
- It is important to properly maintain all tools such as shovels and brooms, which are used for collection.
- Overloaded waste collection vehicles increase maintenance costs, pose a threat to public safety and contribute unnecessarily to the deterioration of streets and roads.
- Clean, freshly painted vehicles send a message to the public that waste and waste handling should not be perceived as something that is dirty and demeaning, but rather a public service that is essential for a clean environment and a better quality of life.
- Records of repairs and maintenance procedures for all waste collection vehicles and equipment should be kept by the LA for reference by the collection crew.
- Waste collection vehicles must be regularly washed and sanitized to minimize odours, insect propagation and to protect worker and public health.
- All collection vehicles should be inspected daily, prior to leaving the garage, in order to identify any that are unsafe or not fully functional for collection.
- The LA has the responsibility and authority to minimize the risk that waste collection vehicle drivers might pose to public safety. Therefore the drivers and cleaners should be trained in the safe and efficient operation of waste collection vehicles.

### Worker Incentives

All LAs should be aware that incentives can be used to improve performance in collection and transport.

- Incentives should be developed to recognize and reward outstanding performance by employees. Award programmes acknowledge an employee's accomplishments in the presence of his or her peers e.g. 'Employee of the Month' award.
- LAs could use a task system, which allows the members of the crew to go home after their daily collection responsibilities have been completed, rather than wait around until a specified leaving time.
- To encourage high quality service, crew supervisors should field customer complaints and then the following day have the crew address the complaints and any problems associated with them.
- Providing meals for the workers is another incentive, which will keep them fit for work. For example, Nuwara Eliya MC provides a glass of milk to the crew before they start on their collection round.
- Change the pay system from a salary-based system (particularly for casual labour) to an amount per ton of waste collected.

#### Assignment 8:

Assess your LA's existing training programme, health and safety initiative and worker incentive scheme. Explore the possibilities of implementing new ideas.



## SESSION 10: INFORMATION MANAGEMENT FOR PERFORMANCE MONITORING AND EVALUATION

### Why Performance Monitoring and Evaluation is Required in SWM

- Solid waste management is considered to be merely an activity in which collection vehicles and equipment are purchased and workers are employed to collect solid waste from generation points and transport them to dump sites.
- Vehicles and equipment are purchased and manpower recruited as and when funds are available.
- The performance of SWM services is evaluated only by visual observations of streets and disposal sites.

In order to develop a more efficient solid waste management system, the efficacy of systems that are currently in operation must be assessed and systems improved through planning and operational management processes.

The indicators useful for assessment of performance in collection and transport can be classified into service performance, resource input and efficiency indicators.

### Service Performance Indicators

#### (a) Collection coverage

A group of indicators can be developed in this category, and these indicators include collection coverage by area, population, quantity of waste and the number of establishments, and/or length of streets or drains from which solid waste is collected.

- Area in km<sup>2</sup> or percentage of the target area.
- Population or percentage of the target population.
- The number of generators or percentage of the target number of houses.
- The quantity or percentage of waste generated by each type of generator in the target area.

#### (b) Collection frequency

Another set of important service performance indicators for solid waste collection service is the frequency of collection.

#### (c) Complaints

- Complaints are a good indicator of service performance.
- Could be categorized into different types such as complaints about uncollected waste, odour, flies and insects, spillage (solid or liquid) during transportation or about attitudes of collection workers.

### Resource Input Indicators

- Human resources input indicators - for each category of staff, the number of staff, average and total wages (daily, monthly and annual) and fringe benefits (e.g. health insurance, pension, paid leave) if any.
- Physical resources input indicators - includes each category of the equipment used for collection and transport. The following information needs to be collated:
  - Its type or make.
  - Volume or capacity.

- Number.
- Purchase cost.
- Year of purchase.
- Amount and cost of fuel consumed.
- Cost of regular service/maintenance.
- Cost of repair and spare parts.
- Average downtime.

### Efficiency Indicators

- A ratio of any service performance indicator to any resource input indicator might be a potentially useful efficiency indicator.
- Weight or volume of solid waste collected daily per Rs of collection cost.
- Weight or volume of solid waste collected directly by the LA daily per Rs of collection cost.
- Weight or volume of solid waste collected by contractors daily per Rs of contractual fees.
- Population served per worker.
- Population served per vehicle.
- Households served per worker.
- Length of street swept per sweeper.

### Collection Time

- All LAs should be aware of the time taken for the collection and transport of waste materials.
- This is another useful indicator for evaluating efficiency.

A method to estimate collection time is given below:

$$Y = a + b + (2n-1)c + n(d) + e + f$$

Where:

**Y** = total collection time

**a** = garage to route time

**b** = actual time collecting waste

**n** = number of trips to disposal site

**c** = time to drive fully loaded truck to disposal facility and return to the collection area

**d** = time to unload solid waste from the vehicle

**e** = time to drive to garage at the end of the trip

**f** = off route time, usually a fraction of Y.

But, **b = z x P**

Where

**P** = number of collection points

**z** = time spent at each collection point

Also,  $V = (P \times v)/r$

Where

**V** = Collectable volume of the vehicle

**v** = average volume collected at each collection point

**r** = compaction ratio = Volume at Collection/Compacted Volume

Using the above expressions, LAs can identify unknown factors on different occasions by assigning values for the known variables, either through approximation or actual studies. Some of the factors can be identified, such as actual time for collecting waste, number of hours additionally needed for collection, number of vehicles needed for collection and number of loads.

### Complaint Redress

- LAs should follow a system that facilitates the receipt, recording and resolution of inquiries and complaints from all categories of service users.
- LAs should be required to record in a bound book all complaints, noting the name and address of each complainant, date and time of complaint, nature of complaint, and nature and date of resolution.
- Using the records from the book of complaints, LAs should compile a summary statistical table of all complaints.
- LAs should respond to all customer complaints within a specified time.
- LAs should identify the responsible crewmembers and take necessary action to resolve complaints.

### Performance Reporting

Good management is essential for keeping a city clean. This requires collection of critical information, which is not just for keeping the records up-to-date, but used effectively for taking corrective measures as well as proper planning for the future. Once the relevant data is collected, it is the duty of the LA to formulate reports for the use of citizens and council members, and for the technical staff to inform them about performance and future planning.

Below are two tables showing:

1. Useful Information Required to Prepare Monthly Performance Reports.
2. Useful Performance Indicators for Monthly Performance Reports.

## Useful Information Required to Prepare Monthly Performance Reports

Category	Information	Unit
General Information	Name of LA	
	Total Area	km <sup>2</sup>
	Total Population	
	Total Length of Roads	km
	Annual Budget Allocation for SWM	
	Budget Allocation for the Year of . . . . .	
Collection Service	Served Population	
	Served Roads	km
	Served Area	km <sup>2</sup>
Collection Quantity	Total waste collected	kg
Collection Crew	Actual hours spent by collection workers	Hours
	Total number of collection workers	
	Total hours scheduled for collection workers	Hours
	Total hours lost due to absenteeism of permanent collection workers	Hours
	Total hours lost due to absenteeism of temporary collection workers	Hours
	Total overtime (OT) hours	Hours
Transportation	Total fuel used for collection this month	Litres
Collection Monitoring	Total number of complaints handled	
	Average of actual collection time, in hours and daily average for this month	Hours
Collection Cost	Total cost for fuel	Rs
	Total salary paid to permanent collection workers	Rs
	Total salary paid to temporary collection workers	Rs
	Total collection cost	Rs
	Total cost for OT payments of collection workers	Rs
	Monthly Budget Allocation for SWM	Rs

## Useful Performance Indicators for Monthly Performance Reports

Category	Monthly Performance Indicator	Expression	Unit
Collection Service	Percentage of collection area in km <sup>2</sup>	$(\text{Collection Area} / \text{Total LA Area}) \times 100$	%
	Percentage of served population	$(\text{Served Population} / \text{Total Population}) \times 100$	%
	Percentage of roads served	$(\text{Length of Served Roads} / \text{Total Length}) \times 100$	%
Collection Quantity	Weight of solid waste collected per Rs 1000 of collection cost	$(\text{Total Weight of SW} / \text{Total Collection Cost}) \times 1000$	kg/Rs 1000
	Population served per worker	$(\text{Served Population} / \text{Total Collection Worker})$	No./Person
Collection Crew	Amount of SW collected in an hour	$\text{Total Weight of SW Collected} / \text{Hours spent by Collection Workers}$	kg/Hour
	Weight of solid waste collected per collection worker	$(\text{Total Weight of SW} / \text{Total of Collection Workers})$	kg/Person
	% of hours lost by permanent collection workers	$(\text{Total Hours of Absenteeism by Permanent Collection Workers} / \text{Total Hours Scheduled for Collection}) \times 100$	%
	% of hours lost by temporary collection workers	$(\text{Total Hours of Absenteeism by Temporary Collection Workers} / \text{Total Hours Scheduled for Collection}) \times 100$	%
Transportation	Waste collected per unit of fuel	$\text{Total Weight of Collected SW} / \text{Total Amount of Fuel Used for Collection}$	kg/Litre
Collection Monitoring	Complaints received	Number of Complaints Received Per Month	Complaints/ Month
	Collection Time	Actual Time Spent on Collection	Hours

Collection Cost	Collection cost per unit of waste	Total Collection Cost / Total SW Collected	Rs/kg
	Collection cost per population	Total Collection Cost / Total Population	Rs/Person
	Fuel cost per unit waste	Total Fuel Cost / Total Waste Collected	Rs/kg
	% in budget allocation	(Total Collection Cost / Average Monthly Budget Allocation) X 100	%
	% of cost for permanent collection worker	(Total Salary Expenses of Permanent Collection Worker / Total Collection Waste) X 100	%
	% of cost for temporary collection worker	(Total Salary Expenses of Temporary Collection Worker / Total Collection Waste) X 100	%
	% of OT cost	(Total OT Cost of Collection Workers / Total Collection Waste) X 100	%

### Solid Waste Collection and Transport (SWCT) Performance Tool

A computerised tool has been developed to analyse the performance of LAs in SWCT. This tool is developed as an 'MS Excel' Worksheet and can be used by LAs to prepare performance reports. The tool is attached to this training module and instructions on how to use this tool are given below.

## Guidelines for Application of Worksheet on Solid Waste Collection and Transport

Name of Worksheet	Location of Data Cell (Highlighted by Pink and Denoted by A – AI)	What Should be Entered	Key Points to Remember
GenInfo	<b>A</b>	Name of LA.	
GenInfo	<b>B</b>	Area of LA.	Only enter the number. DO NOT enter 'km <sup>2</sup> ' with the number.
GenInfo	<b>C</b>	Population.	
GenInfo	<b>D</b>	Length of roads.	Only enter the number. DO NOT enter 'km' with the number.
GenInfo	<b>E</b>	Annual budget allocation for SW.	Only enter the number. DO NOT enter 'Rs' with the number.
GenInfo	<b>F</b>	Year of budget allocation entered in E.	
Service	<b>G</b>	Average collection length of roads per day, for that month.	Only enter the number. DO NOT enter 'km' with the number.
Service	<b>H</b>	Average served population per day, for that month.	
Service	<b>I</b>	Average collection area per day, for that month.	Only enter the number. DO NOT enter 'km <sup>2</sup> ' with the number.
Collection	<b>J</b>	Number of days the LA collected for the month.	Only enter the number. Make sure the figure is not above 31 and check the days, including holidays, if the LA collected on those days.
Collection*	<b>K</b>	Average length of handcart.	Only enter the number. DO NOT enter the 'Unit' with the number. Make sure the figure is in metres.

Collection*	<b>L</b>	Average width of handcart.	Only enter the number. DO NOT enter the 'Unit' with the number. Make sure the figure is in metres.
Collection*	<b>M</b>	Average height of handcart.	Only enter the number. DO NOT enter the 'Unit' with the number. Make sure the figure is in metres.
Collection*	<b>N</b>	Average daily loads .	Only enter the number. Make sure the number of loads estimated is on a DAILY AVERAGE basis.
Crew**	<b>O</b>	Number of working days.	Only the working days. No holidays.
Crew**	<b>P</b>	Number of staff for each category of permanent staff.	Make sure the number of staff given here mainly work for SW (i.e. public health).
Crew**	<b>Q</b>	Total number of absenteeism days for the month for each category of permanent staff.	Make sure the number given is total for all the staff members in that category e.g. if 2 drivers are there, and 1 driver took 3 days leave and the other driver took 2 days leave for that month, then the total absenteeism days will be 5.
Crew**	<b>R</b>	Total OT in hours for the month for each category of permanent staff.	Make sure the number given is total for all the staff members in that category e.g. if 2 drivers are there, and 1 driver took 30 hours OT and the other driver took 20 hours, total OT for that month will be 50 hours.
Crew**	<b>S</b>	Total hours worked for that month for each category of staff on casual basis.	Make sure the number given is total of HOURS worked by all the casual staff members in that category e.g. if 2 casual drivers are used, and 1 driver worked for 45 hours and the other driver worked for 25 hours for that month, then the total hours worked will be 70.



Crew**	<b>T</b>	Total OT in hours for the month by each category of staff on casual basis.	Make sure the number given is total for all the casual staff members in that category e.g. if 2 casual drivers are used and 1 driver took 30 hours OT and the other driver took 20 hours OT for that month, then the total OT hours will be 50.
Monitoring***	<b>U</b>	Total number of complaints for that month.	Make sure that there is a way to record complaints.
Monitoring***	<b>V</b>	Time taken in minutes from when a vehicle leaves the garage to the starting point of collection route.	Make sure this is only for one vehicle involved in the collection.
Monitoring***	<b>W</b>	Total number of trips to the disposal site from the collection area.	This is also for the same vehicle considered in 'V' above.
Monitoring***	<b>X</b>	Average time taken in minutes for a fully loaded vehicle to go to the disposal site and return from the disposal site to the collection area.	Make sure this is calculated on an AVERAGE basis for the same vehicle considered in 'V' above.
Monitoring***	<b>Y</b>	Time in minutes to unload one full load of SW from the vehicle .	Make sure this is calculated on an AVERAGE basis for the same vehicle considered in 'V' above.
Monitoring***	<b>Z</b>	Time in minutes for the vehicle to return to the garage from the collection area at the end of the day.	Make sure that the data is entered for the same vehicle considered in 'V' above.
Monitoring***	<b>AA</b>	Time in minutes taken by workers engaged in activities other than collection of SW, such as lunch time, rest time, drinking tea, etc.	Make sure the data entered for the workers correspond with the same vehicle considered in 'V' above.
Cost	<b>AB</b>	Price of diesel per litre.	Only enter the number. DO NOT enter 'Rs' with the number
Cost****	<b>AC</b>	Total basic salary paid for the month for each category of permanent staff.	Make sure the number given is total for all the staff members in that category e.g. if 2 drivers are there, and 1 driver was paid 13,000/- and the other driver was paid 12,000/- for that month, then the total salary paid will be 25,000/-.

			<p>Make sure this is only the basic salary, before deducting any other dues.</p> <p>Only enter the number. DO NOT enter 'Rs' with the number.</p>
Cost****	<b>AD</b>	Total OT payment for the month for each category of permanent staff.	<p>Make sure the number given is total for all the staff members in that category e.g. if 2 drivers are there, and 1 driver took 3,000/- as OT payment and the other driver took 2,000/- as OT payment for that month, then the total OT payment will be 5,000/-.</p> <p>Only enter the number. DO NOT enter 'Rs' with the number.</p>
Cost****	<b>AE</b>	Total allowances paid (other than OT) for the month for each category of permanent staff.	<p>Make sure the number given is total for all the staff members in that category e.g. if 2 drivers are there, and 1 driver took 1,000/- as allowance (other than OT payment) and the other driver took 500/- as allowance (other than OT payment) for that month, then the total allowance paid will be 1500/-.</p> <p>Only enter the number. DO NOT enter 'Rs' with the number.</p>
Cost****	<b>AF</b>	Total basic salary paid for casual workers for the month for each category.	<p>Make sure the number given is total for all the casual staff members in that category e.g. if 2 casual drivers are there, and 1 driver took 13,000/- and the other driver took 12,000/- for that month, then the total salary paid will be 25,000/-.</p> <p>Make sure this is only the basic salary, before deducting any other dues.</p> <p>Only enter the number. DO NOT enter 'Rs' with the number.</p>

Cost****	<b>AG</b>	Total OT payment for casual workers for the month for each category.	Make sure the number given is total for all the casual staff members in that category e.g. if 2 casual drivers are there, and 1 driver took 3,000/- as OT payment and the other driver took 2,000/- as OT payment for that month, then the total OT payment will be 5,000/-. Only enter the number. DO NOT enter 'Rs' with the number.
Cost****	<b>AH</b>	Total allowances paid (other than OT) for casual workers for the month for each category.	Make sure the number given is total for all the casual staff members in that category e.g. if 2 casual drivers are there, and 1 driver took 1,000/- as allowance (other than OT payment) and the other driver took 500/- as allowance (other than OT payment) for that month, then the total allowance paid will be 1,500/-. Only enter the number. DO NOT enter 'Rs' with the number.
Cost	<b>AI</b>	Total amount of fuel used for that month.	Make sure this is the total amount of fuel used for the vehicles, mainly used for collection of SW. Only enter the number. DO NOT enter 'litres' with the number.

\* Please note that the same type of information should be provided for all the vehicles the LA uses for collection. Make sure ONLY the details of vehicles used for taking the SW to FINAL DISPOSAL are entered here. DO NOT enter the details of vehicles used for transferring the SW from one place to another.

\*\* Please note that the same type of information should be entered for all the available categories of staff mentioned in the worksheet.

\*\*\* Please note that the data provided is for one vehicle; the workers engaged in collection; and that time is estimated on an average day. Actually, the LA has to provide data for each vehicle involved in the collection, but this exercise is for them to understand the principle.

\*\*\*\* Please note that the same type of information should be entered for all the available categories of staff mentioned in the worksheet.

## How to Read the Results in the Reports

Report 1 : Monthly Information Sheet on SWCT

Report 2 : Monthly Performance Indicators on SWCT

Report 3 : Graphs

The difference between Report 1 and 2 is that the indicators in Report 2 are comparable with previous months reports of both your LA and with that of other LAs. Please note that only the important parameters that LAs need to have in their worksheet are mentioned. Also note that LAs may not be able to collect and enter all the data required in the worksheet.

### Report 1 : Important Parameters to be Noted by LAs

Item	Parameter
Collection Quantity	Total waste collected.
Collection Crew	Actual hours spent by collection workers. Total hours scheduled for collection workers. Total hours lost due to absenteeism of collection workers. Total hours spent by casual collection workers. Total hours spent by permanent collection workers. Total OT hours.
Transportation	Total fuel used for collection this month.
Collection Cost	Total cost for fuel. Total salary paid to permanent collection workers. Total salary paid to temporary collection workers. Total collection cost. Total cost for OT payments for collection workers. Total cost for allowances for collection workers. Monthly budget allocation for SW.

## Report 2 : Important Parameters to be Noted by LAs

Item	Parameter
Collection Frequency	Amount of waste collected daily.
Collection Crew	% hours lost by permanent collection workers. % hours worked by casual collection workers.
Collection Cost	Collection cost per unit of waste. Fuel cost per unit of waste.

## Report 3 : Important Graphs

- Waste Generation Pattern
- Waste Collected vs Unit Collection Cost
- Collection Time Distribution
- Waste Collection Cost Pattern
- Budget Allocation vs Actual Cost
- Collection Cost Distribution

The above graphs are prepared based on the information obtained from Reports 1 and 2. LAs will need help in analysing these graphs:

- How has the LA performed compared to previous months?
- What are the reasons for the deterioration in performance compared to previous months?
- What are the solutions to overcome this?
- Who is responsible for implementing solutions?

### Assignment 9:

Establish an information management system and identify the following efficiency indicators for collection and transport in your LA.

- % waste collection  $(\text{Amount of SW collected} / \text{Amount of SW generated}) \times 100$
- % vehicle capacity to waste generated  $(\text{Total Vehicle Capacity (Tons)} / \text{Total SW generated}) \times 100$
- Average spacing of collection bins  $(\text{Total length of roads} / \text{No. of bins})$
- % capacity of waste collection bins  $(\text{Capacity of bins} / \text{Total SW generated}) \times 100$
- Average length of road covered per sweeper  $(\text{Total length of road} / \text{No. of sweepers})$
- Cost per ton of waste collected  $(\text{Operating cost} / \text{Amount of SW generated})$
- % Cost recovery  $(\text{Total revenue generated from SW} / \text{Total operating cost for SW}) \times 100$
- Manpower per ton  $(\text{Total manpower employed for SWM} / \text{Total SW collected in tons})$

## SESSION 11: ACTION PLAN FOR IMPROVING WASTE COLLECTION AND TRANSPORT

An Action Plan is required to implement the improvements to the waste collection and transport system. This will be an important tool for LAs to systematically approach the issues identified in collection and transport. A time-defined Action Plan, specifically for the improvement of collection and transport, should be developed involving the following steps:

- Identify the key issues.
- Analyse and list remedial activities.
- Discuss options and costs with the public.
- Prioritise activities.
- Assign responsibilities for each activity.
- Set timeframe for implementation.
- IMPLEMENT.

The results of these actions need to be monitored and evaluated periodically. Depending on the results, modifications may be required to maximise the outcomes. A simple format of an Action Plan specifically for implementing activities discussed in this session is developed and shown below.

### **Assignment 10:**

Develop an Action Plan to improve the collection and transport of waste materials.

### Action Plan for Improvement of Waste Collection and Transport

Intervention	Activities	Responsible Team & Team Leader	Due Date	Outputs
Action Plan	<ul style="list-style-type: none"> <li>Preparation of Action Plan for collection and transport.</li> </ul>			<ul style="list-style-type: none"> <li>Completed Action Plan.</li> </ul>
Service Area and Users	<ul style="list-style-type: none"> <li>Data collection for Assignment 1.</li> <li>Data entry for Assignment 1.</li> <li>Complete Assignment 1.</li> <li>Complete Assignment 2.</li> </ul>			<ul style="list-style-type: none"> <li>List of Service and Non Service Areas.</li> <li>Collection Database in Excel.</li> </ul>
Evaluation of Current System	<ul style="list-style-type: none"> <li>Data Collection for Assignment 3.</li> <li>Data Entry for Assignment 3.</li> <li>Complete Assignment 3.</li> <li>Complete Assignment 4.</li> <li>Complete Assignment 5.</li> </ul>			<ul style="list-style-type: none"> <li>List of individual bins, public bins and litter bins.</li> <li>List on Collection Service Methods.</li> <li>List on Collection Frequency Details.</li> <li>Updated Collection Database in Excel with above information.</li> </ul>
Routing and Scheduling	<ul style="list-style-type: none"> <li>Complete Assignment 6.</li> </ul>			<ul style="list-style-type: none"> <li>A map showing a feasible route for collection.</li> <li>A schedule for collection.</li> </ul>
Financial Management in Collection and Transport	<ul style="list-style-type: none"> <li>Collect relevant cost data.</li> <li>Data Entry for Assignment 7.</li> <li>Complete Assignment 7.</li> </ul>			<ul style="list-style-type: none"> <li>Budget information on SWM.</li> <li>Monthly Financial Report on SWCT.</li> <li>SWCT monthly cost data in Excel.</li> </ul>

<p>Personnel Management</p>	<ul style="list-style-type: none"> <li>• Complete Assignment 8.</li> </ul>	<ul style="list-style-type: none"> <li>• Report on current situation.</li> <li>• Action Plan for implementing new ideas.</li> </ul>
<p>Information Management System for SW Collection and Transport</p>	<ul style="list-style-type: none"> <li>• Collect relevant data.</li> <li>• Data Entry for Assignment 9.</li> <li>• Complete Assignment 9.</li> </ul>	<ul style="list-style-type: none"> <li>• Performance database in Excel.</li> <li>• Monthly performance reports.</li> </ul>
<p>Action Plan for Improvement in Solid Waste Collection and Transport</p>	<ul style="list-style-type: none"> <li>• Identify stakeholders.</li> <li>• Identify key issues.</li> <li>• Carry out stakeholder consultations.</li> <li>• Prioritise issues.</li> <li>• Commence Implementation.</li> <li>• Complete Assignment 10.</li> </ul>	<ul style="list-style-type: none"> <li>• Action Plan with short, medium and long-term activities.</li> </ul>



**Scheduling Format for Waste Collection**

Name of Road / Institutions	Collection Frequency						Name of Supervisor
	Daily	Alternate Days	Three Times a Week	Two Times a Week	Once a Week	Other	

*Fill the appropriate Collection Frequency columns with Date and Time*

## EXERCISE 1: GROUP DISCUSSION AND PRESENTATION

**(35 – 45 minutes)**

**Time for discussion:** 15 minutes

**Presentation:** 5 minutes for each LA

Discuss and present the results to the audience on the following:

1. Brief introduction on SW Collection related to:
  - Served population
  - Amount of waste
  - Road length served
  - Served area
  - Special events
2. Constraints
3. Goals

Use different coloured idea cards to write about SW Collection, Constraints and Goals.

## EXERCISE 2: SERVICE AREA MAP

**(25 – 30 minutes)**

**Time for exercise:** 15 minutes

**Presentation** by ONE group followed by discussion for 10 minutes.

Using the given map of the LA, identify the different types of waste generators and types of waste generated by them. Use different coloured markers to show waste generators as per the convention given below:

Waste Generators	Colour
Residential	Red
Market	Blue
Industrial	Black
Commercial	Green
Medical	Red Cross
Agricultural	Green Triangle
Slaughterhouse	Black Triangle

Also, mark the types of waste likely to be generated by the particular group as per the convention shown below:

- Kitchen waste – 1
- Wastewater treatment sludge – 2
- Vegetable and fruit waste – 3
- Used syringes and dressings – 4
- Used stationery – 5
- Hay or other crop waste – 6
- Slaughterhouse waste – 7

## EXERCISE 3: EVALUATION OF COLLECTION OPTIONS

**(30 – 45 minutes)**

**Exercise Time:** 15 minutes

A market (Pola) with about 100 stalls operates two days a week. The LA uses maximum effort to collect the waste on these two days but is yet to achieve success.

- Issues being faced are:
  - Waste scattering
  - Odour
  - Scavenging animals
  - Rodents
  - Leachate
- The LA uses three common bins to store waste as shown in the picture.
- The LA transports the waste in an open truck as shown in the picture, once a week.

(Each group will be given copies of pictures, so that they can point to modifications.)

Identify the weaknesses in the system and propose modifications/improvements to the system. Your recommendations could be made under the following headings:

- Point of Collection – from which point wastes need to be collected and from which types of users.
- Types of containers.
- Transportation.

## EXERCISE 4: ROUTING AND SCHEDULING

**(45 minutes)**

**Exercise Time:** 20 minutes

**Presentation:** 20 minutes

Use the Service Area Map you developed in the earlier session and design an effective routing for collection of solid waste.

## EXERCISE 5: PERFORMANCE REPORTING AND INFORMATION MANAGEMENT

**Write data manually:** 15 minutes

**Enter data into computer:** 30 minutes

**Explanation:** 15 minutes

A sheet will be given to write down the relevant data for January, February and March. Data will be directly entered into the computer as pre-determined numbers.

Use the SWCT Worksheet to prepare performance reports.

## REFERENCES:

**USAID**, *Solid Waste Privatization Procedural Manual*; produced by **Abt Associates for the United States Agency for International Development Project No. 263-0255, 2003.**

**US EPA**, *Decision Maker's Guide to Solid Waste Management, Volume II, (EPA 530-R-95-023), 1995.*

**JICA**, *The Study on Improvement of Solid Waste Management in Secondary Cities in Sri Lanka, 2003.*

**City Managers' Association Gujarat / International City/County Management Association**, *Urban Indicators and Performance Measurement Program, 2000-2001.*