	SRI VIDYA COLLEGE OF ENGINEERING & TECHNOLOGY **VIRUDHUNAGAR** **DEPARTMENT OF CIVIL ENGINEERING**	

QUESTION WITH ANSWERS

DEPT: CIVIL –IV **SEM:VII**

SUB.CODE/ NAME: EN 6501/Municipal Solid Waste Management.

UNIT 3- COLLECTION & TRANSFER.

PART - A (2 marks)

1.What is meant by Collection points?

Collection points: These affect such collection system components as crew size and storage, which ultimately control the cost of collection. Note that the collection points depend on locality and may be residential, commercial or industrial.

2.**What is meant by Collection frequency?**

Collection frequency: Climatic conditions and requirements of a locality as well as containers and costs determine the collection frequency. In hot and humid climates, for example, solid wastes must be collected at least twice a week, as the decomposing solid wastes produce bad odour and leachate.

3. **What is meant by Storage containers?**

Storage containers: Proper container selection can save collection energy, increase the speed of collection and reduce crew size. Most importantly, containers should be functional for the amount and type of materials and collection vehicles used. Containers should also be durable, easy to handle, and economical, as well as resistant to corrosion, weather and animals. In residential areas, where refuse is collected manually, standardized metal or plastic containers are typically required for waste storage.

4.**Whatis meant by Collection route?**

Collection route: The collection programme must consider the route that is efficient for collection. An efficient routing of collection vehicles helps decrease costs by reducing the labour expended for collection. Proper planning of collection route also helps conserve energy and minimise working hours and vehicle fuel consumption.

5.**Whatis meant by Transfer station?**

Transfer station :A transfer station is an intermediate station between final disposal option and collection point in order to increase the efficiency of the system, as collection vehicles and crew remain closer to routes. If the disposal site is far from the collection area, it is justifiable to have a transfer station, where smaller collection vehicles transfer their loads to larger vehicles, which then haul the waste long distances. In some instances, the transfer station serves as a pre-processing point, where wastes are dewatered, scooped or compressed.

6.Whatis meant by Containers/storage bins?

Containers/storage bins

The design of an efficient waste collection system requires careful consideration of the type, size and location of containers at the point of generation for storage of wastes until they are collected. While single-family households generally use small containers, residential units, commercial units, institutions and industries require large containers. Smaller containers are usually handled manually.

7.What is meant by Collection crew?

Collection crew: The optimum crew size for a community depends on labour and equipment costs, collection methods and route characteristics. The size of the collection crew also depends on the size and type of collection vehicle used, space between the houses, waste generation rate and collection frequency.

QUESTION WITH ANSWERS

DEPT: CIVIL –IV **SEM:VII**

SUB.CODE/ NAME: CE 2039 /Municipal Solid Waste Management.

UNIT 3- COLLECTION & TRANSFER.
Part B-(16 marks).

1.Explain the collection of solid wastes.

OVERVIEW

For the final disposal of the wastes generated (see Unit 2), it is imperative that we put in place an effective waste collection system, we will build on this description and discuss in detail the various aspects of collection system. Accordingly, we will first explain the components of waste collection such as storage, collection crew, route, transfer station, etc. We will then discuss each of these components. We will also discuss the design, operation and implementation of waste collection.

COLLECTION COMPONENTS

As described, waste collection does not mean merely the gathering of wastes, and the process includes, as well, the transporting of wastes to transfer stations and/or disposal sites. To elaborate, the factors that influence the waste collection system include the following (EPA, 1989 and Ali, et al., 1999):

(i) **Collection points:** These affect such collection system components as crew size and storage, which ultimately control the cost of collection. Note that the collection points depend on locality and may be residential, commercial or industrial.

(ii) **Collection frequency:** Climatic conditions and requirements of a locality as well as containers and costs determine the collection frequency. In hot and humid climates, for example, solid wastes must be collected at least twice a week, as the decomposing solid wastes produce bad odour and leachate.

- compatibility, i.e., the containers must be compatible with collection equipment.
- public health and safety, i.e., the containers should be securely covered and stored.
- ownership, i.e., the municipal ownership must guarantee compatibility with collection equipment.

(iv) **Collection crew** (see also Subsection 3.3.1)**:** The optimum crew size for a community depends on labour and equipment costs, collection methods and route characteristics. The size of the collection crew also depends on the size and type of collection vehicle used, space between the houses, waste generation rate and collection frequency. For example, increase in waste generation rate and quantity of wastes collected per stop due to less frequent collection result in a bigger crew size.

Note also that the collection vehicle could be a motorised vehicle, a pushcart or a trailer towed by a suitable prime mover (tractor, etc.). It is possible to adjust the ratio of collectors to collection vehicles such that the crew idle time is minimised. However, it is not easy to implement this measure, as it may result in an overlap in the crew collection and truck idle time. An effective collection crew size and proper workforce management can influence the productivity of the collection system. The crew size, in essence, can have a great effect on overall collection costs. However, with increase in collection costs, the trend in recent years is towards:

- decrease in the frequency of collection;
- increase in the dependence on residents to sort waste materials;
- increase in the degree of automation used in collection.

This trend has, in fact, contributed to smaller crews in municipalities.
(v) **Collection route** (see also Subsection 3.3.2)**:** The collection programme must consider the route that is efficient for collection. An efficient routing of *Unit 3: Waste Collect ion, Storage and Transport 91* collection vehicles helps decrease costs by reducing the labour expended for collection. Proper planning of collection route also helps conserve energy and minimise working hours and vehicle fuel consumption. It is necessary therefore to develop detailed route configurations and collection schedules for the selected collection system. The size of each route, however, depends on the amount of waste collected per stop, distance between stops, loading time and traffic conditions. Barriers, such as railroad, embankments, rivers and roads with heavy traffic, can be considered to divide route territories. Routing (network) analyses and planning can:

- increase the likelihood of all streets being serviced equally and consistently;
- help supervisors locate or track crews quickly;
- provide optimal routes that can be tested against driver judgement and experience.

(vi) **Transfer station** (see also Section 3.4)**:** A transfer station is an intermediate station between final disposal option and collection point in order to increase the efficiency of the system, as collection vehicles and crew remain closer to routes. If the disposal site is far from the collection area, it is justifiable to have a transfer station, where smaller collection vehicles transfer their loads to larger vehicles, which then haul the waste long distances. In some instances, the transfer station serves as a pre-processing point, where wastes are dewatered, scooped or compressed. A centralised sorting and recovery of recyclable materials are also carried out at transfer stations (EPA, 1989). The unit cost of hauling solid wastes from a collection area to a transfer station and then to a disposal site decreases, as the size of the collection vehicle increases.
This is due to various reasons such as the following:

- labour costs remain constant;
- the ratio of payload to vehicle load increases with vehicle size;

- the waiting time, unloading time, idle time at traffic lights and driver rest period are constant, regardless of the collection vehicle size.

Efficiency: Do the services help minimise the cost per household?

Effectiveness: Do the services satisfy the community needs?

Equity: Do the services address equally the concerns of all social and demographic groups?

Reliability: Do the services ensure consistency?

Safety and environmental impact: Do the services ensure safety of workers, public health and protection of the environment?

Note also that various management arrangements, ranging from municipal services to franchised services and under various forms of contracts are, typically, in vogue for waste collection. One of the critical decisions to be made at the planning stage, therefore, is as to who – the public or private agencies – operates the collection system, though the final decision depends on the existing conditions and options for the local decision-makers (EPA, 1989).

2.Explain the storage of solid wastes.

STORAGE: CONTAINERS/COLLECTION VEHICLES
As mentioned in Unit 1, waste storage is an important component of a waste management system. Waste storage encompasses proper containers to store wastes and efficient transport of wastes without any spillage to transfer stations/disposal sites. We will analyse these two aspects of waste storage in Subsections 3.2.1 and 3.2.2.

3.2.1 Containers/storage bins

The design of an efficient waste collection system requires careful consideration of the type, size and location of containers at the point of generation for storage of wastes until they are collected. While single-family households generally use small containers, residential units, commercial units, institutions and industries require large containers. Smaller containers are usually handled manually whereas the larger, heavier ones require mechanical handling. The containers may fall under either of the following two categories:

(i) Stationary containers: These are used for contents to be transferred to collection vehicles at the site of storage.

(ii) Hauled containers: These are used for contents to be directly transferred to a processing plant, transfer station or disposal site for emptying before being returned to the storage site.

The desirable characteristics of a well-designed container are low cost, size, weight, shape, resistance to corrosion, water tightness, strength and durability (Phelps, et al., 1995). For example, a container for manual handling by one person should not weigh more than 20 kg, lest it may lead to occupational health hazards such as muscular strain, etc. Containers that weigh more than 20 kg, when full, require two or more crew members to manually load and unload the wastes, and which result in low collection

efficiency.
Containers should not have rough or sharp edges, and preferably have a handle and a wheel to facilitate mobility. They should be covered to prevent rainwater from entering (which increases the weight and rate of decomposition of organic materials) into the solid wastes. The container body must be strong enough to resist and discourage stray animals and scavengers from ripping it as well as withstand rough handling by the collection crew and mechanical loading equipment. Containers should be provided with a lifting bar, compatible with the hoisting mechanism of the vehicle. The material used should be light, recyclable, easily moulded and the surface must be smooth and resistant to corrosion. On the one hand, steel and ferrous containers are heavy and subject to corrosion; the rust peels off exposing sharp edges, which could be hazardous to the collection crew. On the other, wooden containers (e.g., bamboo, rattan and wooden baskets) readily absorb and retain moisture and their surfaces are generally rough, irregular and difficult to clean.

3.Explain the Components of refuse collection.

Components of refuse collection

A refuse collection service requires vehicles and labour. In order to deploy the vehicles and workers efficiently, a clear understanding of the three main components of refuse collection is necessary:

1. travel to and from the collection area;
2. the collection process (transfer of the wastes from storage to collection vehicles, and travel between successive collection points); and
3. the delivery process (transport of the contents of the vehicle to the processing or the disposal site).

During non-working hours, collection vehicles should be kept in a garage with enclosed parking space. The distance between the garage and the collection area should be kept to a minimum because time spent travelling to and from the collection area is not productive. In the case of motor vehicles, this requirement may have to be balanced against the need to centralise facilities for maintenance and fuel supplies, and to centralise the allocation and control of drivers and vehicles.

The slow speed of animal carts and handcarts requires the provision of closely spaced district depots. District depots also are efficient tools for the control of the collectors. The many methods of transferring wastes from storage to the collection vehicle fall into the following three main categories:

1. Direct emptying of a portable storage container into the vehicle, normally used when the vehicle can be positioned close to the containers.
2. Emptying of a portable storage container into a transfer container (usually a larger container or basket), which is then emptied into the storage compartment of the vehicle; the large container is normally used when the location of the storage container is a long distance from the route of the vehicle in order to avoid non-productive time.
3. Transfer of loose wastes stored on the ground, which usually requires that the wastes be raked or shovelled into the vehicle.

These three categories have been presented in descending order of level of effort required. Thus, the first is the most efficient in terms of labour and vehicle productivity; it is also the method that maintains human contact with the wastes to a minimum.

Travel time between successive collection points depends, first of all, upon the distance between them. When collection points are located some distance apart (as is the case with large communal storage sites), travel by motor vehicle will be at normal road speed and the collectors will ride on the vehicle. This is an efficient method of transporting the workers between sites.

However, when collection is from house to house, the collectors generally walk the short distances between containers and the collection vehicle correspondingly moves slowly and at intervals. For this element of travel, the motor vehicle is not used efficiently. The vehicle incurs heavy wear on the clutch and transmission, as well as high fuel consumption. Handcarts and animal carts are much more efficient in this situation, because they can operate at their optimum speeds and no energy is used while they are stationary.

For collectors walking from house to house, the distance to be walked is proportional to the number of people in a team. A single individual walks from one house to the next. In a three person team, each person collects from every third house; thus, labour productivity declines as team size increases. On the other hand, vehicle productivity increases with team size since the vehicle is loaded more quickly.

In the delivery process, a full vehicle usually travels at normal road speed from the last collection point to the processing or disposal site. This represents maximum productivity for the vehicle, but lost time for the collectors if they accompany it. Handcarts and animal carts are inefficient for this operation because of their slow speeds and limited capacities.

The following conclusions can be drawn:

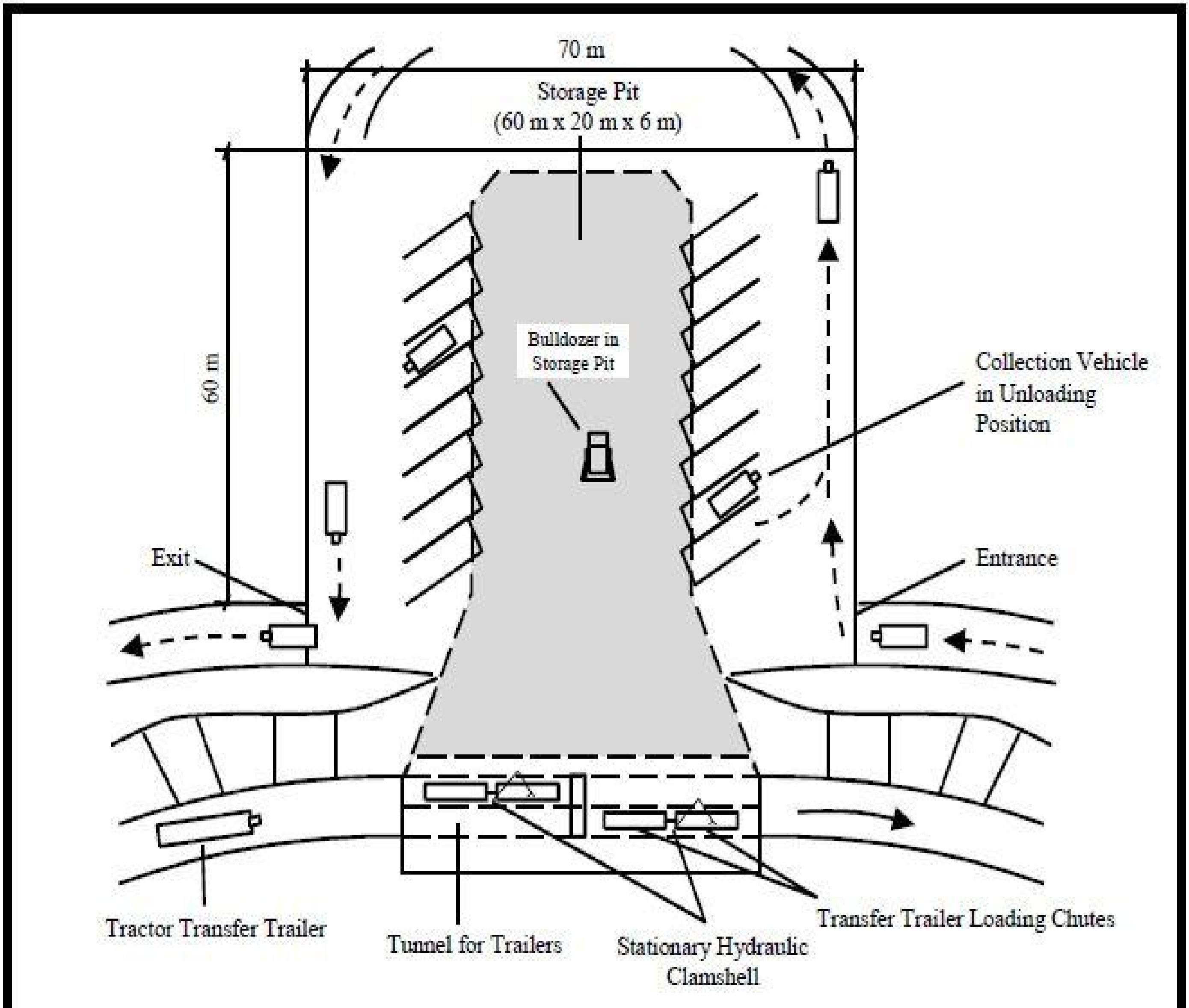
• Minimum physical infrastructure for waste collection includes a central garage, with parking space for motor vehicles, and district depots for assembling and controlling collectors, handcarts, and animal carts. The locations of the depots should minimise travel time between depot and working area.
• Systems that provide for the direct emptying of portable storage containers into a vehicle offer the highest productivity and the lowest health risk to workers.
• Large teams yield low labour productivity and high vehicle productivity in the direct collection of wastes from residences.

• Handcarts and animal carts may be more efficient than motor vehicles for the house- to-house collection activities.
• Motor vehicles are usually the most efficient means of transport of full (large) loads from the last collection point on a collection route to the processing or disposal site.

4.Explain the TRANSFER operations and plant layout.

TRANSFER operations and plant layout
The operation of a transfer station can be divided into the following phases: unloading, loading, transport, and discharge. The design concepts for transfer systems are described under each of the main phases.
1. Unloading
This phase involves the unloading of collection vehicles and, if necessary, temporary storage of wastes. The following two basic alternatives can be utilised for the unloading phase:
Collection vehicles can either unload directly into containers, or into a storage area or pit. The wastes can then be loaded from the storage area into transfer vehicles, as described below.
1.1 Direct unloading
A system that uses direct unloading involves the discharge of the wastes from the collection vehicles directly into transfer vehicles or the vehicle loading systems (e.g., compactors), i.e., the design does not incorporate a waste storage area as part of the system. Direct unloading requires a two-level arrangement. In this arrangement, the collection vehicles drive up a ramp to the upper level in order to discharge their contents through a chute into either a transfer vehicle or a loading system installed on the lower level, as shown in Figure IV-19. As an alternative to gravity loading, a direct loading system can also employ a wheeled loader to push the wastes directly into the transfer vehicles.
One of the basic requirements of the direct unloading system is that either the transfer vehicles in operation must keep pace with the frequency of arrival of collection vehicles at the transfer station, or extra transfer vehicles must be purchased for use as temporary storage. These operational alternatives support the efficient coordination of incoming and outgoing wastes and, thereby, avoid delays in the unloading of collection vehicles and the resultant delays in the
collection operations. Such logistical coordination is difficult to achieve in a large-scale system (i.e., large processing capacity) where there is a steady flow of collection vehicles entering the transfer station and periods of high frequencies of unloading of delivered waste. Therefore, the direct unloading system generally is implemented only as a small-scale system, such as a neighbourhood transfer station in a small city, or a rural transfer station. In these situations, the quantity of waste handled at the transfer stations would be on the order of 200 to 300 Mg/day. If the transfer station is one of large processing capacity (i.e., greater than 200 to 300 Mg/day), provision should be made for a sufficient number of spare transfer vehicles to ensure that the delivering collection vehicles are not delayed unduly due to the inability of the transfer facility to load out the waste in a timely manner.

One of the main advantages of the direct unloading system is that it involves a small capital investment in terms of civil works. Since a pit to store the wastes is excluded in the direct loading system, in order to result in a simple facility and to save expense, the size of the building can be small. Furthermore, investment in specialised systems to control doors and insects under suchconditions can usually also be small, since substantial doors and prevalence of insects generally are associated with storage of waste.



A. Plan View

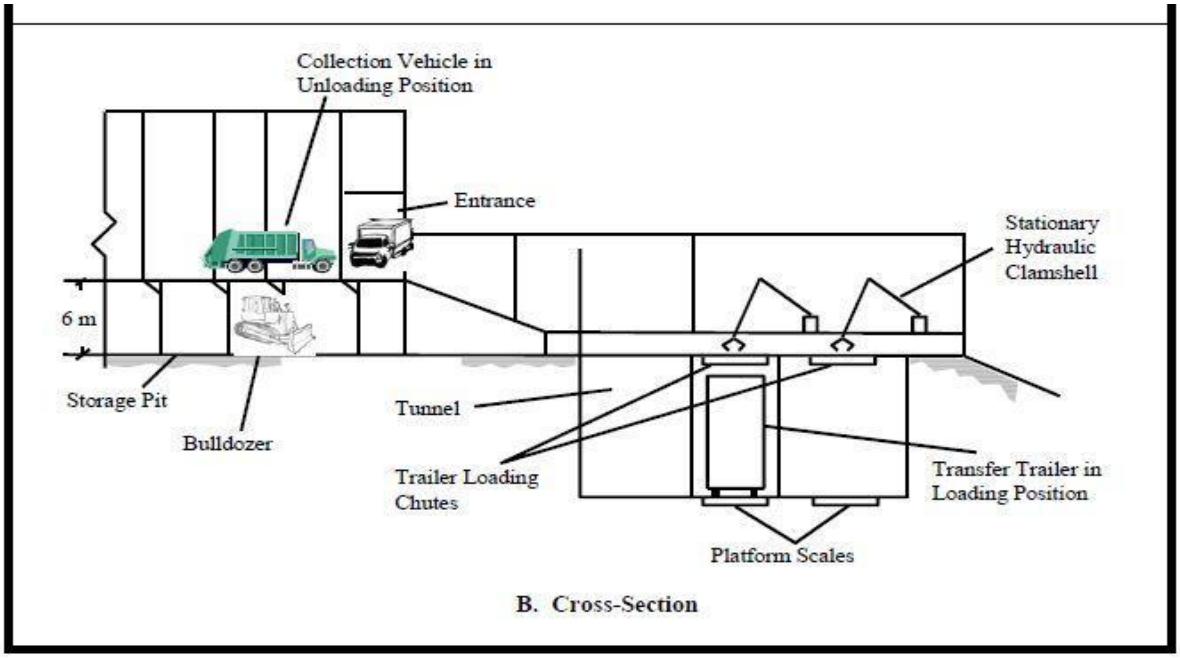


Figure IV-22. Enclosed large-capacity (2,000 Mg/day) storage-load transfer station

TRANSFER operations and plant layout.

The types of structures used to house a waste transfer operation range from none at all (open-air) to large, enclosed concrete and metal buildings. Open-air transfer stations work well in rural areas with dry climates. Rural areas with wet weather can utilise a small shelter over the unloading area, loading area, or both.

Most transfer station buildings in developing countries are fabricated of sheet metal, concrete, or brick. The specific type of design and landscaping is a function of location, i.e., locally available materials, available financial resources, and local preferences. Transfer station buildings typically are equipped with water sprays and/or systems for controlling air emissions such as dust, motor vehicle exhaust, and doors. The building should include offices

and facilities for the workers, e.g., restrooms, showers, etc. Designs of transfer stations in the United States incorporate viewing areas so that public education and public relations' campaigns can be conducted from those areas.

The station should also be equipped with at least one truck scale for weighing inbound

and outbound wastes. An inbound weigh scale is important for managing the operation and for levying disposal fees. Large, modern transfer stations also incorporate truck scales in the locations where the long-haul transfer vehicles are loaded. This design permits loading of the vehicles to their maximum allowable payloads, thus optimising the cost of transport of waste to the disposal site.