



**JECRC Foundation**



JAIPUR ENGINEERING COLLEGE  
AND RESEARCH CENTRE

# JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE DEPARTMENT OF CIVIL ENGINEERING

**Class – VI Semester /III Year**

**Subject –S&HWM**

**Chapter – 3**

**Presented by – Teekam Singh (Assistant Professor )**

# VISION AND MISSION OF INSTITUTE

## VISION

To become a renowned center of outcome based learning, and work towards academic, professional, cultural and social enrichment of the lives of individuals and communities.

## MISSION

Focus on evaluation of learning outcomes and motivate students to inculcate research Aptitude by project based learning. Identify, based on informed perception of Indian, Regional and global needs, areas of focus and provide platform to gain knowledge and solutions. Offer opportunities for interaction between academia and industry. Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders can emerge in a range of professions.

# VISION AND MISSION OF DEPARTMENT

## VISION

To become a role model in the field of Civil engineering for the sustainable development of the society.

## MISSION

To provide outcome base education

To create a learning environment conducive for achieving academic excellence

To prepare civil engineers for the society with high ethical values.

# CONTENTS

- Waste Collection: Components of waste collection,
- waste collection containers, their characteristics, types,
- waste collection vehicles,
- Collection frequency,
- collection route,
- transfer stations

# Components of waste collection

- Collection points
- Collection frequency
- Storage containers
- Collection crew
- Collection rout
- Transfer station
- Efficiency: Do the services help minimize 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?

# 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.

# Collection frequency

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, standardised metal or plastic containers are typically required for waste storage. When mechanised collection systems are used, containers are specifically designed to fit the truck-mounted loading mechanisms. While evaluating residential waste containers, consider the following:

efficiency, i.e., the containers should help maximise the overall collection efficiency.

convenience, i.e., the containers must be easily manageable both for residents and collection crew.

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

# Storage containers

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. Collection efficiency largely depends on the demography of the area (such as income groups, community, etc.), where collection takes place. While deciding collection frequency, therefore,

Cost, e.g., optimal collection frequency reduces the cost as it involves fewer trucks, employees and reduction in total route distance;

storage space, e.g., less frequent collection may require more storage space in the locality;

sanitation, e.g., frequent collection reduces concerns about health, safety and nuisance associated with stored refuse.

# Storage containers

The containers may fall under either of the following two categories:

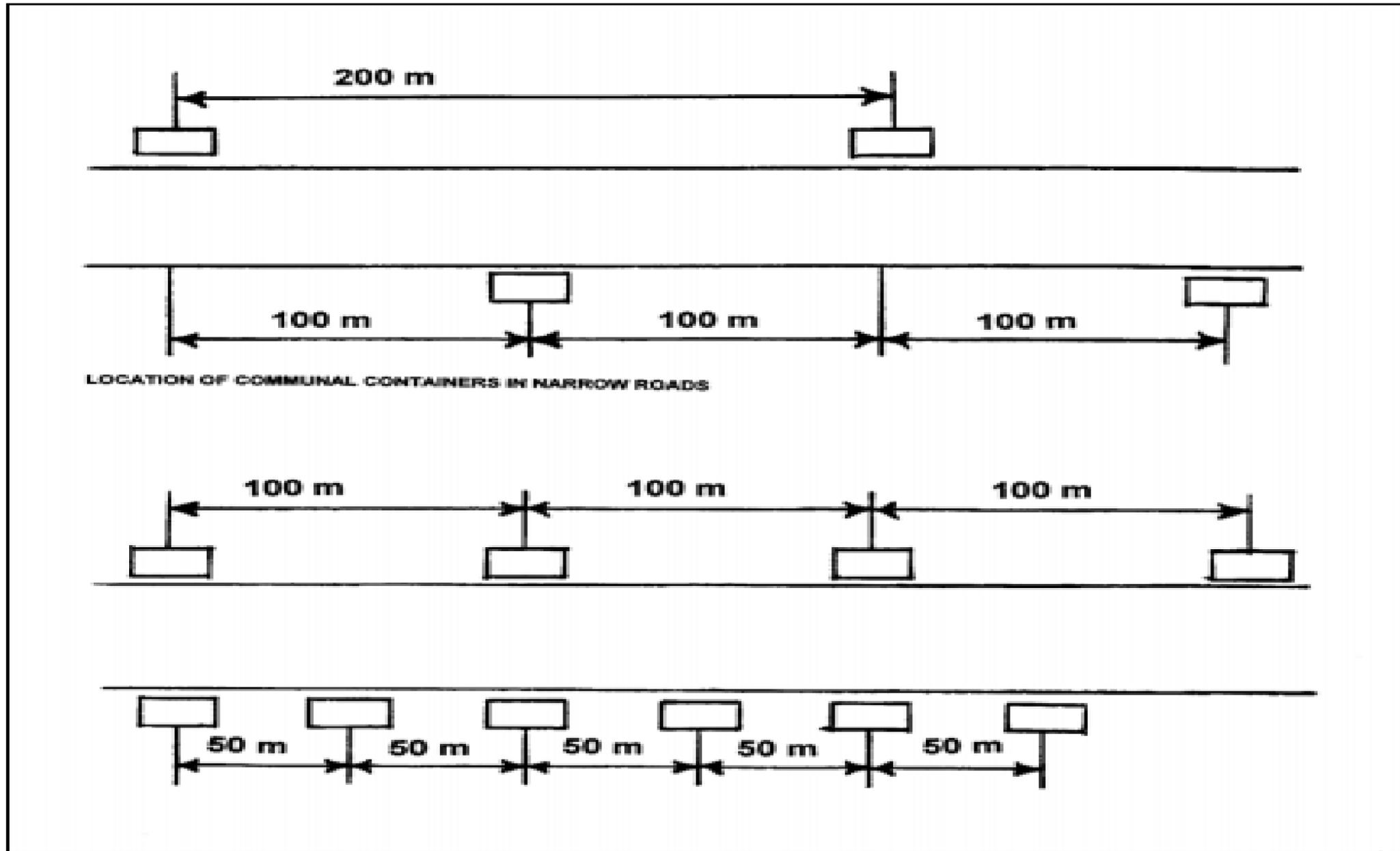
- (i) Stationary containers: These are used for contents to be transferred to collection vehicles at the site of storage.
  
- (ii) Hauled containers: These are used for contents to be directly transferred to a processing plant, transfer station or disposal site for emptying before being returned to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

# Storage containers

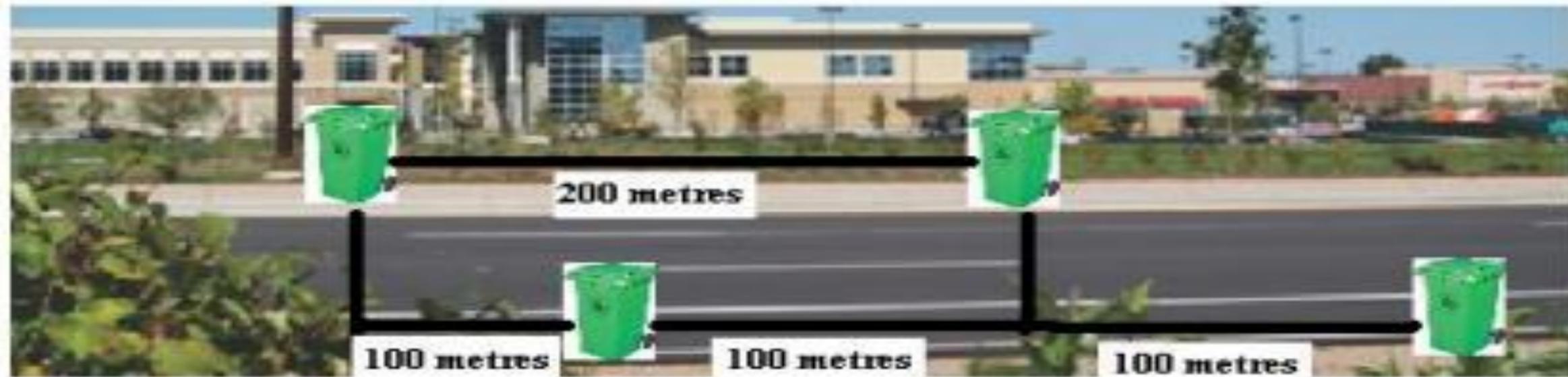
## The desirable characteristics

- well-designed container are low cost
- size
- Weight(should not weigh more than 20 kg)
- shape
- resistance to corrosion
- water tightness
- strength and durability

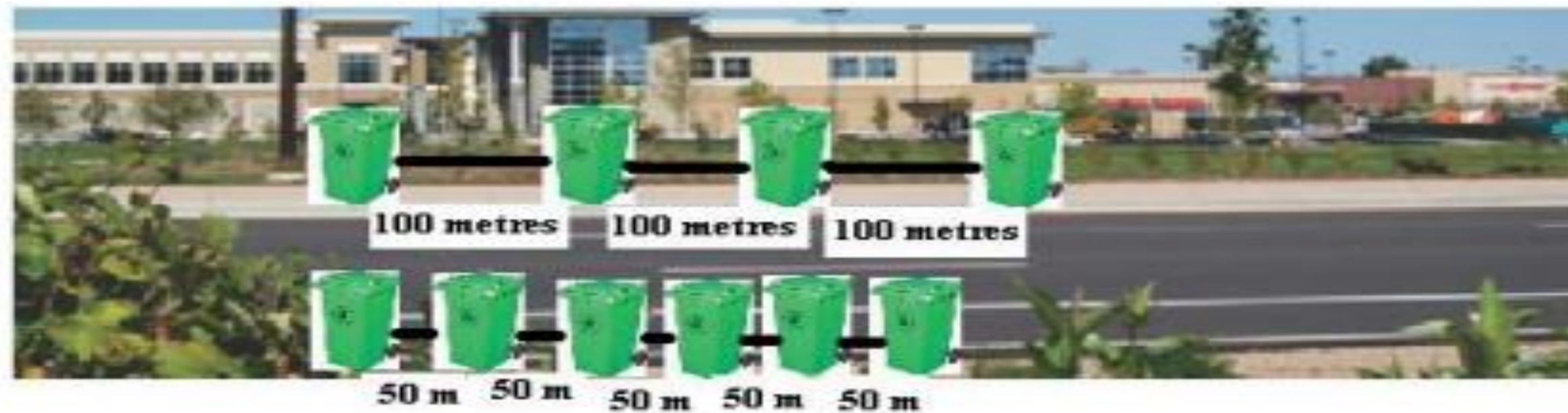
# Storage containers



# Storage containers



**Location of communal containers in Narrow Roads**



## Storage containers

It is advisable to place the containers 100 – 200 m apart for economic reasons. The communal containers are usually staggered such that the effective distance of 100 m is maintained. This means that the furthest distance the householder will have to walk is 50 meters. However, in narrow streets with low traffic, where the house owner can readily cross the street, a longer distance is advisable. If the collection vehicle has to stop frequently, say, at every 50 m or so, fuel consumption increases, and this must be avoided.

# Storage containers



## Disadvantage of Storage containers

**Disadvantages** The major disadvantage of communal containers is the potential lack of maintenance and upgrading. The residuals and scattered solid wastes emit foul odours, which discourage residents from using the containers properly. In addition, if fixed containers are built below the vehicle level, the collection crew may be held responsible for sweeping and loading the solid wastes into transfer containers before being loaded into the collection vehicle. Sweeping and cleaning the communal containers of residuals obviously impinge on the time of the crew members and take a longer time than if the wastes are placed in smaller containers. As fixed communal containers have higher rates of failure, their use is not advisable.

# 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. 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.

# 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 minimize 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

# 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 preprocessing 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.

# Collection vehicles

Almost all collections are based on collector and collection crew, which move through the collection service area with a vehicle for collecting the waste material. The collection vehicle selected must be appropriate to the terrain, type and density of waste generation points, the way it travels and type and kind of material . It also depends upon strength, stature and capability of the crew that will work with it. The collection vehicle may be small and simple (e.g., two-wheeled cart pulled by an individual) or large, complex and energy intensive (e.g., rear loading compactor truck). The most commonly used collection vehicle is the dump truck fitted with a hydraulic lifting mechanism.

- 1.Small-scale collection vehicles
- 2.Non-compactor trucks
3. Compactor truck

# 1.Small-scale collection vehicles

These are common vehicles used for waste collection in many countries and are generally used in rural hilly areas. these can be small rickshaws, carts or wagons pulled by people or animals, and are less expensive, easier to build and maintain compared to other vehicles

They are suitable for populated areas with narrow lanes, and squatter settlements, where there is relatively low volume of waste generated. Some drawbacks of these collection vehicles include limited travel range of the vehicles and weather exposure that affect humans and animals.



## 2. Non-compactor trucks

Non-compactor trucks are efficient and cost effective in small cities and in areas where wastes tend to be very dense and have little potential for compaction.

Trucks with capacities of 10 – 12 m<sup>3</sup> are effective, if the distance between the disposal site and the collection area is less than 15 km. If the distance is longer, a potential transfer station closer than 10 km from the collection area is required. Non-compactor trucks are generally used, when labour cost is high. Controlling and operating cost is a deciding factor, when collection routes are long and relatively sparsely populated.



### 3. Compactor truck

Compaction vehicles are more common these days, generally having capacities of 12 – 15 m<sup>3</sup> due to limitations imposed by narrow roads. Although the capacity of a compaction vehicle is similar to that of a dump truck, the weight of solid wastes collected per trip is 2 to 2.5 times larger since the wastes are hydraulically compacted. The advantages of the compactor collection vehicle include the following:

- containers are uniform, large, covered
- waste is set out in containers so that the crew can pick them up quickly;
- health risk to the collectors and odour on the streets are minimised;
- waste is relatively inaccessible to the waste pickers.



# TRANSFER STATION

transfer station is a centralized facility, where waste is unloaded from smaller collection vehicles and re-loaded into large vehicles for transport to a disposal or processing site. This transfer of waste is frequently accompanied by removal, separation or handling of waste. In areas, where wastes are not already dense, they may be compacted at a transfer station. The technical limitations of smaller collection vehicles and the low hauling cost of solid waste, using larger vehicles, make a transfer station viable. Also, the use of transfer station proves reasonable, when there is a need for vehicles servicing a collection route to travel shorter distances, unload and return quickly to their primary task of collecting the waste



Transfer station

## factors that affect the selection of a transfer station:

- Types of waste received.
- Processes required in recovering material from wastes.
- Required capacity and amount of waste storage desired.
- Types of collection vehicles using the facility.
- Types of transfer vehicles that can be accommodated at the disposal facilities.
- Site topography and access

# Types of transfer station:

- Small to medium transfer stations
- Large transfer stations

## ➤ Small to medium transfer stations

- These are direct-discharge stations that provide no intermediate waste storage area. The capacities are generally small (less than 100 tonnes/day) and medium (100 to 500 tonnes/day). Depending on weather, site aesthetics and environmental concerns, transfer operations of this size may be located either indoor or outdoor. More complex small transfer stations are usually attended during hours of operation and may include some simple waste and materials processing facilities. For example, it includes a recyclable material separation and processing centre. The required overall station capacity (i.e., the number and size of containers) depends on the size and population density of the area served and the frequency of collection.

# Large transfer stations

These are designed for heavy commercial use by private and municipal collection vehicles. The typical operational procedure for a larger station is as follows:

when collection vehicles arrive at the site, they are checked in for billing, weighed and directed to the appropriate dumping area;

collection vehicles travel to the dumping area and empty the wastes into a waiting trailer, a pit or a platform; after unloading, the collection vehicle leaves the site, and there is no need to weigh the departing vehicle, if its weight (empty) is known;

Transfer vehicles are weighed either during or after loading. If weighed during loading, trailers can be more consistently loaded to just under maximum legal weights and this maximizes payloads and minimizes weight violations

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# Designs for larger transfer operations

Direct-discharge non-compaction station

Platform/pit non-compaction station

Compaction station

## Direct-discharge non-compaction station

In these stations, waste is dumped directly from collection vehicle into waiting transfer trailers and is generally designed with two main operating floors. In the transfer operation, wastes are dumped directly from collection vehicles (on the top floor) through a hopper and into open top trailers on the lower floor. The trailers are often positioned on scales so that dumping can be stopped when the maximum payload is reached. A stationary crane with a bucket is often used to distribute the waste in the trailer. After loading, a cover or tarpaulin is placed over the trailer top. However, some provision for waste storage during peak time or system interruptions should be developed. Because of the use of little hydraulic equipment, a shutdown is unlikely and this station minimises handling of waste.

## Platform/pit non-compaction station:

In this arrangement, the collection vehicles dump their wastes onto a platform or into a pit using waste handling equipment, where wastes can be temporarily stored, and if desired, picked through for recyclables or unacceptable materials. The waste is then pushed into open-top trailers, usually by front-end loaders. Like direct discharge stations, platform stations have two levels. If a pit is used, however, the station has three levels. A major advantage of these stations is that they provide temporary storage, which allows peak inflow of wastes to be levelled out over a longer period. Construction costs for this type of facility are usually higher because of the increased floor space. This station provides convenient and efficient storage area and due to simplicity of operation and equipment, the potential for station shutdown is less.

## Compaction station:

In this type of station, the mechanical equipment is used to increase the density of wastes before they are transferred. The most common type of compaction station uses a hydraulically powered compactor to compress wastes. Wastes are fed into the compactor through a chute, either directly from collection trucks or after intermediate use of a pit. The hydraulic ramp of the compactor pushes waste into the transfer trailer, which is usually mechanically linked to the compactor (EPA, 1995).

# Capacity

(i) Pit stations: Based on the rate at which wastes can be unloaded from collection vehicles:

$$C = P_c \times (L/W) \times (60 \times H_w/T_c) \times F$$

Based on rate at which transfer trailers are loaded:  $C = (P_t \times N \times 60 \times H_t)/(T_t + B)$

$C$  = Station capacity (tonnes/day);  $P_c$  = Collection vehicle payload (tonnes);  $L$  = Total length of dumping space (feet);  $H_w$  = Hours per day that waste is delivered;  $T_c$  = Time (in minutes) to unload each collection vehicle;  $F$  = Peaking factor (ratio of the number of collection vehicles received during an average 30-minute period to the number received during a peak 30-minute period);  $L_p$  = Length of push pit (feet);  $N_p$  = Number of push pits;  $B_c$  = Total cycle time for clearing each push pit and compacting waste into trailer

# Capacity

(ii) Direct dump stations:  $C = (N_n \times P_t \times F \times 60 \times H_w) / [((P_t/P_c) \times (W/L_n)) \times T_c + B]$

(iii) Hopper compaction stations:  $C = (N_n \times P_t \times F \times 60 \times H_w) / [(P_t/P_c \times T_c) + B]$

(iv) Push pit compaction station:  $C = (N_p \times P_t \times F \times 60 \times H_w) / [(P_t/P_c \times W/L_p \times T_c) + B_c + B]$

$B_c$  = Total cycle time for clearing each push pit and compacting waste into trailer;  $P_t$  = Transfer trailer payload (tonnes);  $N$  = Number of transfer trailers loading simultaneously;  $H_t$  = Hours per day used to load trailers (minutes);  $B$  = Time to remove and replace each loaded trailer (minutes);  $T_t$  = Time to load each transfer trailer (minutes);  $N_n$  = Number of hoppers;  $L_n$  = Length of each hopper (feet).



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*Thank  
you!*

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