Solid Waste Management:

Collection

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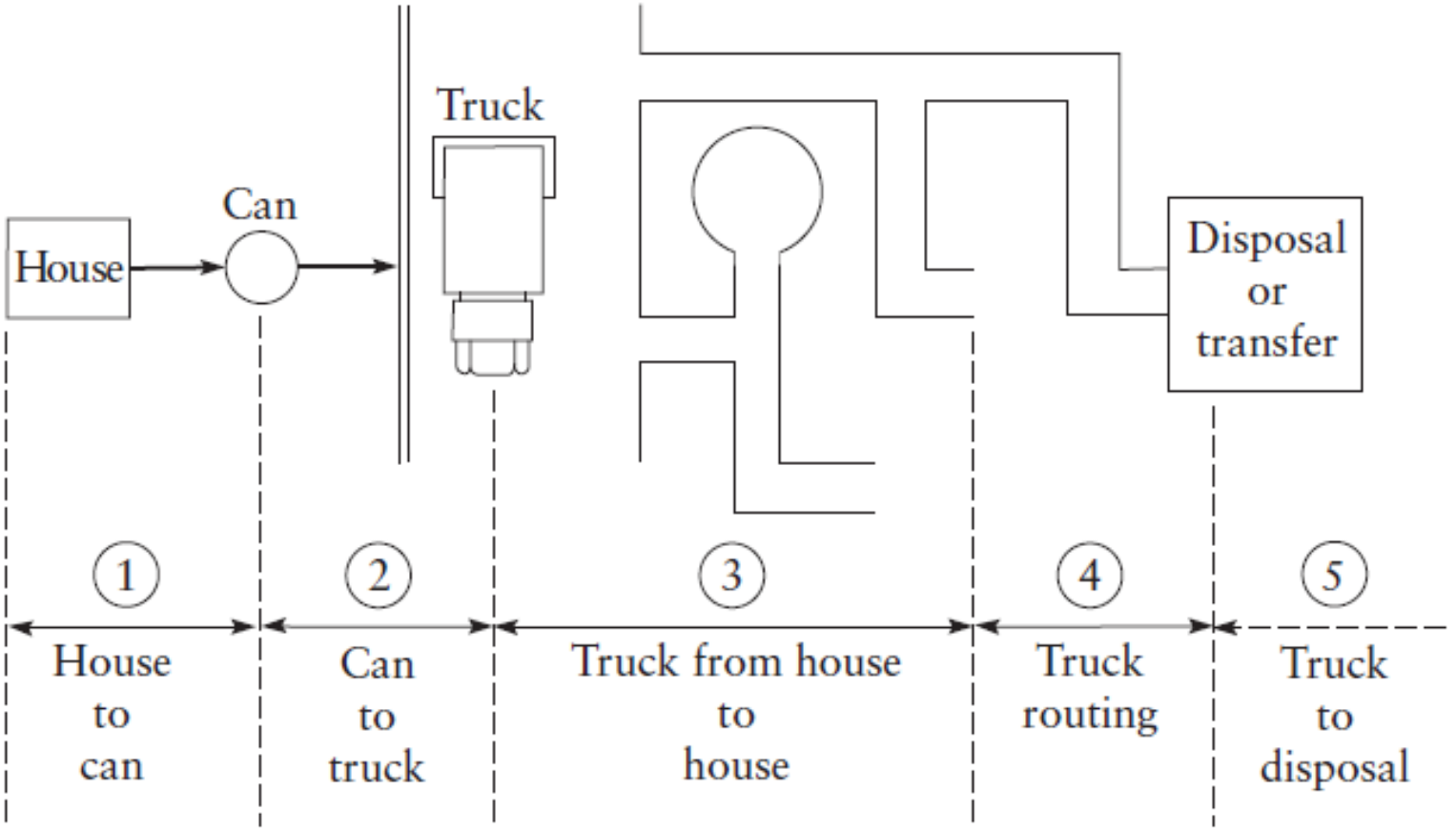
Preface

- Solid waste collection is an exercise in reducing entropy!
- Solid waste collection systems are invariably person/truck systems
- The collection of MSW is done by persons who traverse a town in trucks and then ride with the truck to a site where the refuse is transferred from the small truck into trailers, larger vans, barges, or railway cars for long-distance transport or the final site such as the landfill, compost site, or materials recovery facility.

Five phases of municipal solid waste collection



Phase 1: House to Can

- The individual homeowner must transfer whatever is considered waste (defined as material having no further value to the occupant) to the refuse can, which may be inside or outside the home.

- Communities use tax funds to operate the solid waste collection and disposal system, or they charge for the service just as they charge for water consumption and wastewater disposal. Such a system gives the generators of waste ***carte blanche*** to generate as much as they please because the cost is the same regardless of how much they contribute.

- Some communities have adopted a volume-based fee system to pay for solid waste collection and specify the containers that must be used.


شركة الكهرباء الأردنية المساهمة العامة المحدودة - عمان
(كشف حساب)
قسيمة المشترك

اسم المشترك	[redacted]		(17 21 6155)
رقم ونوع الاشتراك	02/440107/001901		سكني
فترة الاستهلاك	من: ********	إلى: ********	
رقم الفاتورة	20100899	رقم الإضبارة	158292
رقم الملف	02/40127/158292	معامل الضرب	1.0000
رقم العداد	000002006139479	الخصم (٪)	0
القراءة السابقة	القراءة الحالية	كمية الاستهلاك	
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البيان	فلس	دينار
قيمة الإستهلاك	***	**
فرق اسعار الوقود	***	**
اجرة العداد	***	**
فلس الريف	***	**
رسم التلفزيون	***	**
رسم النفايات	***	**
قيمة الفاتورة	***	**
حساب التسوية	***	**
القيمة المطلوبة	***	**

تفاصيل الذمم السابقة

رقم الفاتورة	فلس	دينار
20100700	785	118
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رصيد سابق	000	0
مجموع قيمة الذمم	785	118

تفاصيل الذمم السابقة

الرسوم

• يفصل التيار ما لم تسدد الفاتورة خلال شهر من تاريخ بدون إشعار آخر.
• لا تعتبر هذه القسيمة وصلا بقيمة المطالبة الا بعد ختمها بالة او ختم صندوق الشركة و البنوك المعتمدة و مكاتب شركة البريد الاردني.
ملاحظات:

- In a volume-based fee system, residents are offered cans in three sizes— such as 30-, 60-, or 90-gallon (110-, 230-, and 340-liter) cans. The fee for refuse service is based on the size of can used.

- Other communities are taking this approach one step further by weighing every can and charging by actual weight, called the weight-based fee system.

- Volume-based fee systems have generated renewed interest in the home compactor. This device, originally introduced in the 1950s without much success, sits under the kitchen counter and compresses about 20 lb (9 kg) of refuse into a convenient block within a special bag.

- The bulk density of the compacted refuse is about 1400 lb/yd3(830 kg/m3), achieving a compaction ratio of about 1:5.

Example

A family of four people generates solid waste at a rate of 2 lb/cap/day and the bulk density of refuse in a typical garbage can is about 200 lb/yd3. If collection is once a week, how many 30-gallon garbage cans will they need, or the alternative, how many compacted 20-lb blocks would the family produce if they had a home compactor? How many cans would they need in that case?

SOLUTION

$$2 \text{ lb/cap/day} \times 4 \text{ persons} \times 7 \text{ days/week} = 56 \text{ lb refuse}$$

$$56 \text{ lb}/200 \text{ lb/yd}^3 = 0.28 \text{ yd}^3$$

$$0.28 \text{ yd}^3 \times 202 \text{ gal/yd}^3 = 57 \text{ gal}$$

They will require two 30-gallon cans.

If the refuse is compacted into 20-lb blocks, they would need to produce three such compacted blocks to take care of the week's refuse. If each block of compacted refuse is 1400 lb/yd^3, the necessary volume is

$$\frac{56 \text{ lb}}{1400 \text{ lb/yd}^3} \times 202 \text{ gal/yd}^3 = 8.1 \text{ gal}$$

They would need only one 30-gal can.

Quiz

A family of five people generates solid waste at a rate of 3 lb/cap/day and the bulk density of refuse in a typical garbage can is about 200 lb/yd3. If collection is once a week, how many 30-gallon garbage cans will they need, or the alternative, how many compacted 20-lb blocks would the family produce if they had a home compactor? How many cans would they need in that case?

Phase 2: Can to Truck

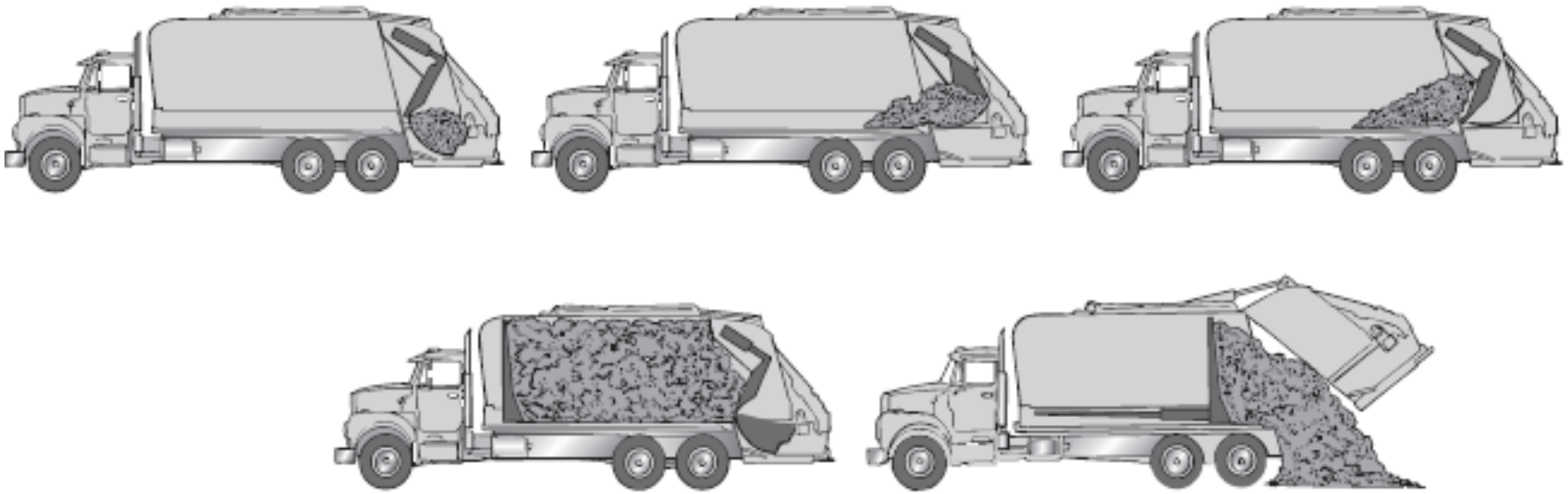
- The most common system of getting the solid waste into the truck was the collectors going to the backyard, emptying the garbage cans into large tote containers, and carrying these to the waiting truck.

- This system was not only expensive in dollar cost to the community, but it was expensive in terms of the extremely high injury rate to the collectors.

- The traditional trucks used for residential and commercial refuse collection are rear-loaded and covered compactors called packers, and vary in size and design with 16- and 20-yd3 (12- and 15-m3) loads being common.

The compaction (packing) mechanism

Commonly, the refuse is emptied from garbage cans into the back of the packers where it is scooped up by hydraulically operated compaction mechanisms that compress the refuse from a loose density of about 100 to 200 lb/yd3 (60 to 120 kg/m3) to about to 600 to 700 lb/yd3 (360 to 420 kg/m3).



Two revolutionary changes

- The first is wide acceptance of **the can-on-wheels** idea, known as waste wheelers.

  Communities that have converted from the manual system to the fully automated system have saved at least 50% in collection costs, much of it in reduced medical costs.

- The second is widespread use of plastic bags.

  Plastic bags, of course, have some serious disadvantages. Bags can rip while they are transported to the curb, and can be torn apart by small animals seeking food, resulting in the garbage being spread all over the sidewalk or alley.

Phase 3: Truck from House to House

- Once the refuse is in the truck, it is compacted as the truck moves from house to house.
- The higher the compaction ratio, the more refuse the truck can carry before it has to make a trip to the landfill.

EXAMPLE 3-2

Assume each household produces 56 lb of refuse per week (as in Example 3-1). How many customers can a 20-yd^3 truck that compacts the refuse to 500 lb/yd^3 collect before it has to make a trip to the landfill?

SOLUTION

$$20\ yd^3 \times 500\ lb/yd^3 = 10{,}000\ lb$$

$$10{,}000\ lb\ /\ 56\ lb/customer = 178\ customers$$

(Note that the refuse weighs 5 tons, and if the truck itself weighs 2 tons, the common 6-ton residential load limit can be exceeded before the truck is full.)

- The size of the truck crew can range from one to over five people. If backyard pickup is offered, a larger crew size is needed because the crew must service cans that might be at some distance from the collection vehicle.

- Curbside pickup requires a smaller crew, and of course, fully automated systems require only one person.

- Studies have shown that the greatest overall efficiencies can be attained with the smallest possible crews. For curbside refuse collection, three-person crews do not collect three times as much refuse as a one-person crew.

EXAMPLE 3-3

Suppose a crew of two people requires 2 minutes per stop, at which they can service four customers. If each customer generates 56 lb of refuse per week, how many customers can they service if they did not have to go to the landfill?

SOLUTION

A working day is 8 hours, minus breaks and travel from and to the garage—say 6 productive hours, $6 \times 60 = 360$ minutes. At 2 minutes per stop, a truck should be able to make 180 stops and service $180 \times 4 = 720$ customers.

(Note, however, from Example 3-2, that the truck has to go to the landfill after only 178 customers or fewer still if its wheel loading is exceeded for the streets!)

- An organized way of estimating the amount of time the crew actually works in collecting refuse is to enumerate all of the various ways they spend time. The total time in a workday can be calculated as:

$$Y = a + c(b) + c(d) + e + f + g$$

where

Y = the total time in a workday
a = time from the garage to the route, including the marshaling time or that time needed to get ready to get moving
b = actual time collecting a load of refuse
c = number of loads collected during the working day
d = time to drive the fully loaded truck to the disposal facility, deposit the refuse, and return to the collection route
e = time to take the final (not always full) load to the disposal facility and return to the garage
f = official breaks including time to go to the toilet
g = other lost time such as traffic jams, breakdowns, etc.

Solve Example 3-4 and 3-5, page 71

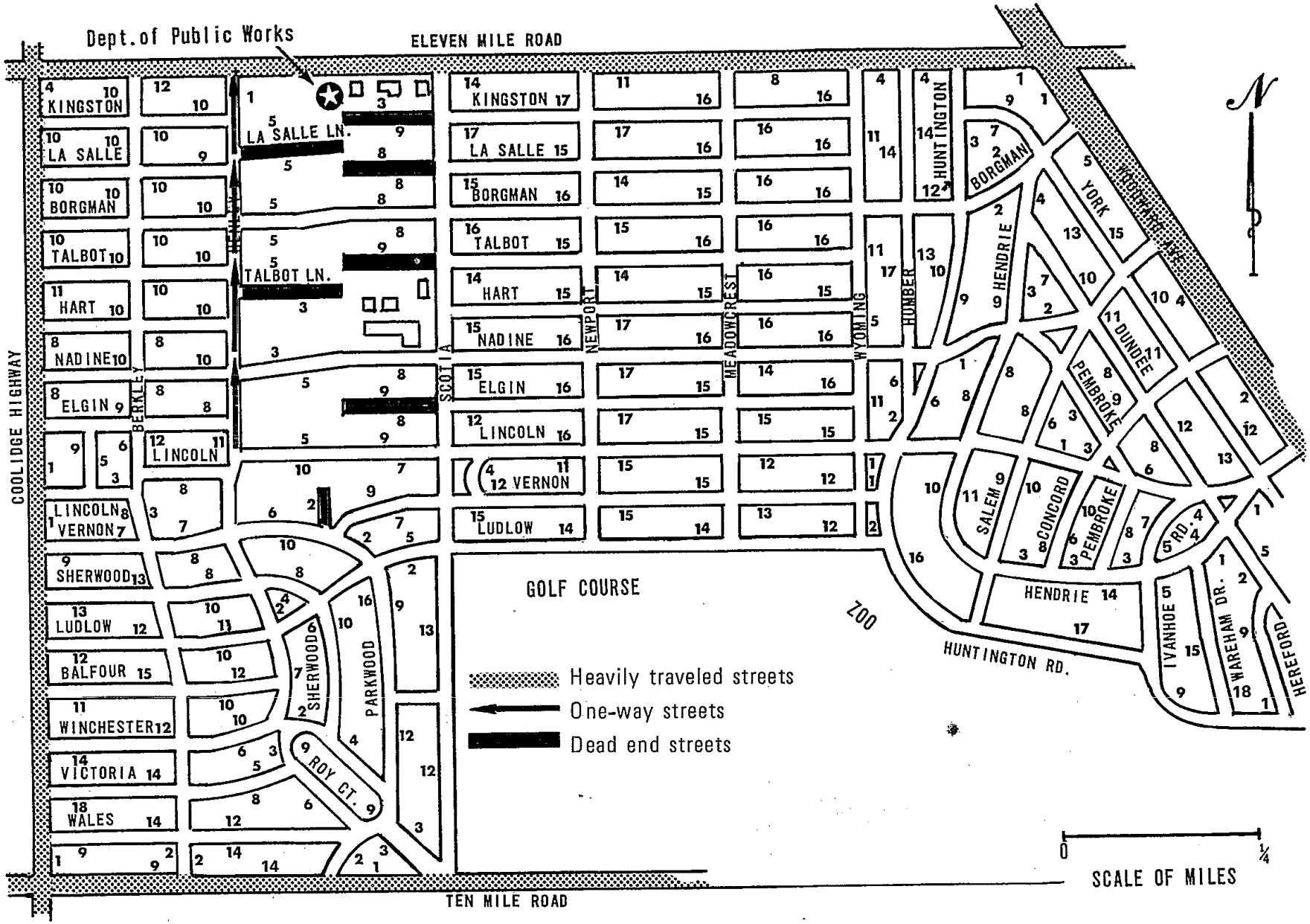
Phase 4: Truck Routing

- The routing of a vehicle within its assigned collection zone is often called ***microrouting***.
- The ***deadheading*** is passing a collection point again after a previous pickup, and should be minimized!

- Thus, if a route can be devised that has the least amount of deadheading possible, it is the most efficient collection route.
- The objective is to minimize the driving time on the collection route through minimizing the dead (head) distance.

what data are required for routing?

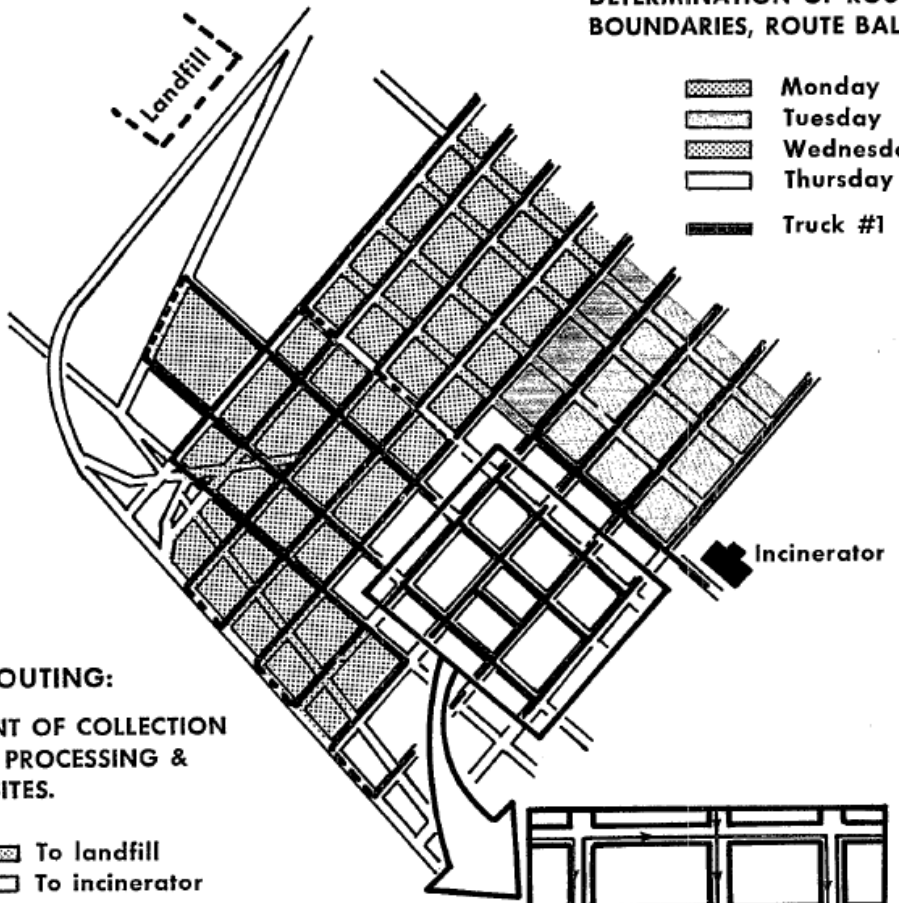
All the information required for routing can be recorded on community maps. First, indicate on the community map(s) the number and type (residential, apartment, commercial, institutional, industrial) of services per street segment for each side of the street. The remaining street segments with no services on them are non-collection segments. Next, identify all one-way, dead end, and heavily traveled streets. Indicate which corner-lot residents (if any) should be asked to place their waste on a specific street segment. Finally, indicate, for each street segment or service area, whether the crews are to collect one or both sides of the street on a pass.


Dept.of Public Works
ELEVEN MILE ROAD
COOLIDGE HIGHWAY
TEN MILE ROAD
KINGSTON
LA SALLE
BORGMAN
TALBOT
HART
NADINE
ELGIN
LINCOLN
VERNON
SHERWOOD
LUDLOW
BALFOUR
WINCHESTER
VICTORIA
WALES
LA SALLE LN.
TALBOT LN.
BERKLEY
SCOTIA
NEWPORT
MEADOWCREST
WYOMING
HUMBER
HUNTINGTON
HENDRIE
YORK
DUNDEE
PEMBROKE
SALEM
CONCORD
RD.
IVANHOE
WAREHAM DR.
HEREFORD
ROY CT.
PARKWOOD
GOLF COURSE
ZOO
HUNTINGTON RD.
Heavily traveled streets
One-way streets
Dead end streets
SCALE OF MILES

what preparations are needed for routing?

In developing an efficient collection system, micro-routing as defined here is actually the last of four tasks that might precede implementation. In order, these tasks are:

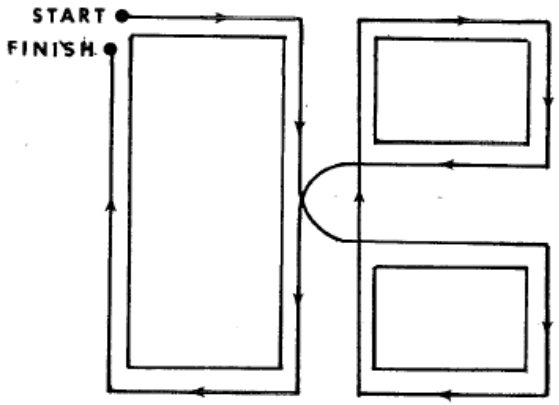
- Review and evaluation of existing policies and methodologies
- Macro-routing
- Districting and route balancing
- Micro-routing
- Implementation



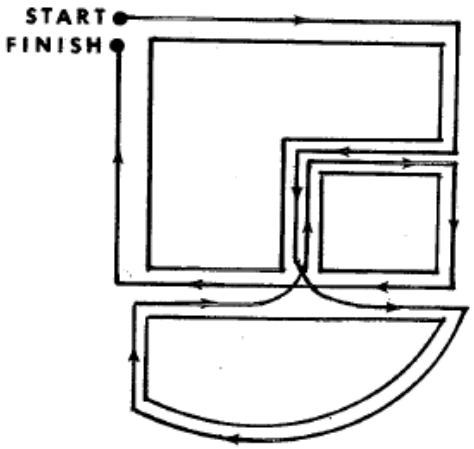
Rules for micro-routing

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 traveled and one-way streets (see rules 3 and 4).
3. Collection from heavily traveled 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 left turns to a minimum, collect the dead-end streets when they are to the right 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 clockwise turns around blocks.
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 clockwise

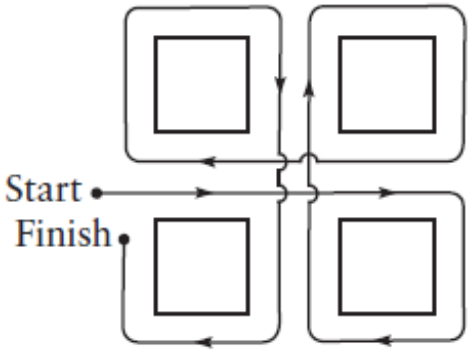
Examples

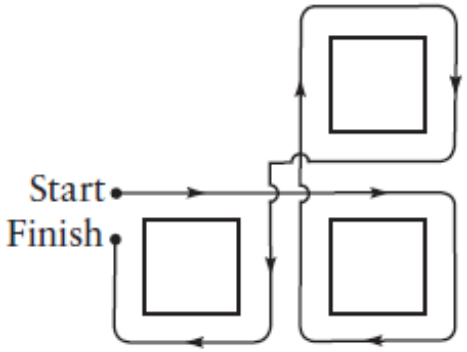


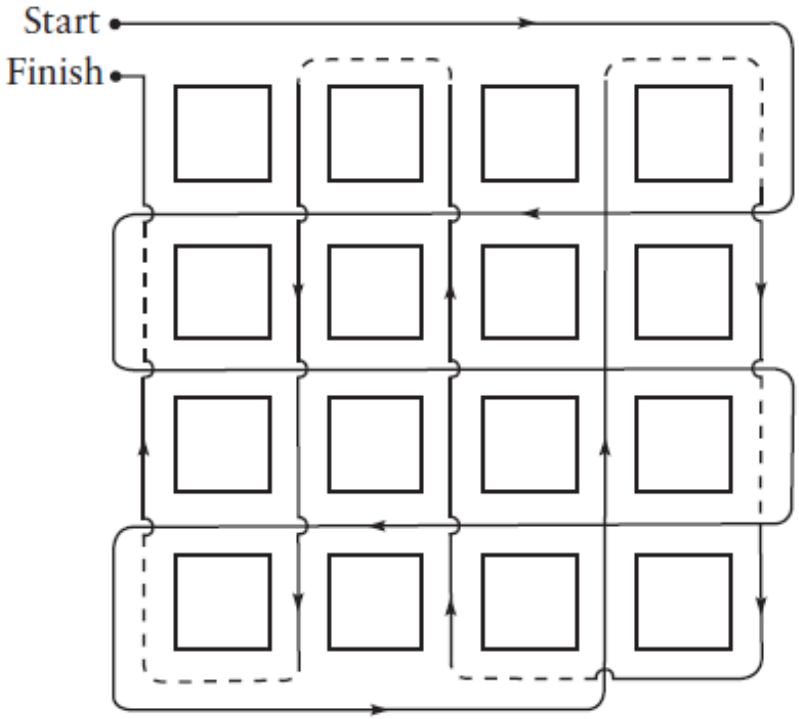
THREE-BLOCK CONFIGURATION



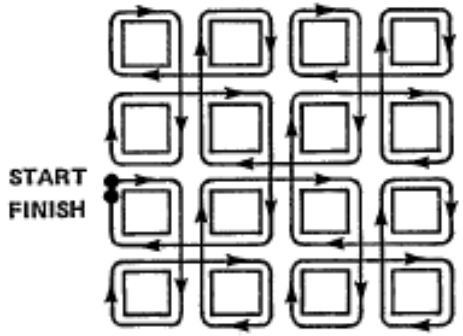
VARIATION OF THREE-BLOCK CONFIGURATION



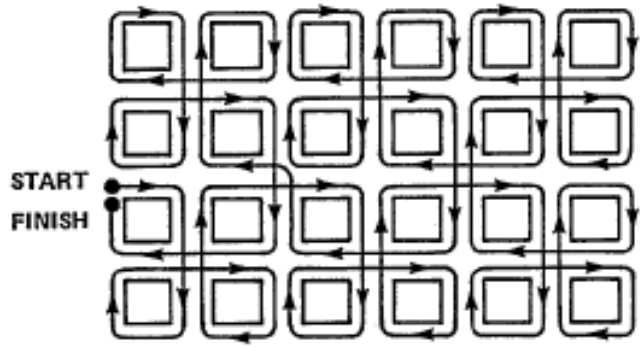




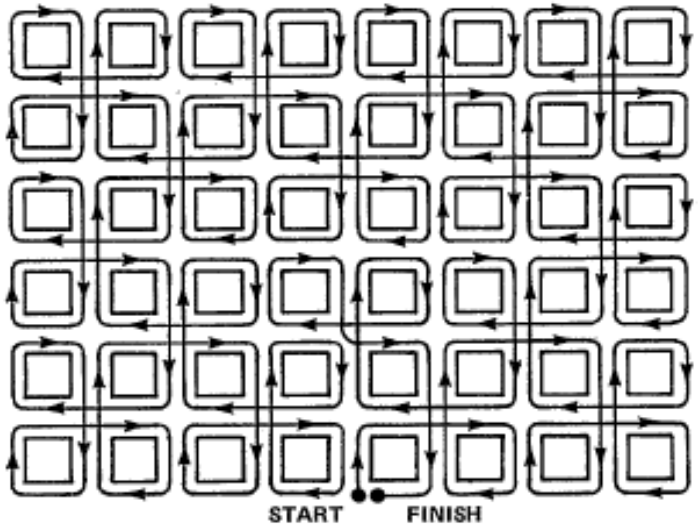
Examples



4x4 BLOCKS
NO LEFT TURNS
NO DEAD DISTANCE



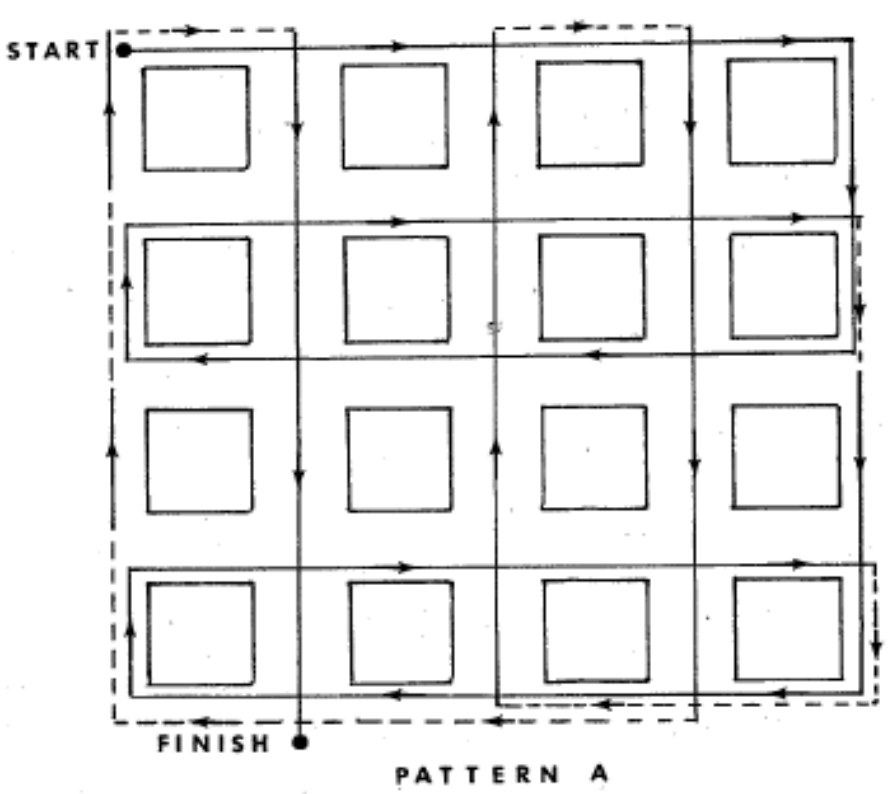
4x6 BLOCKS
ONE LEFT TURN
NO DEAD DISTANCE



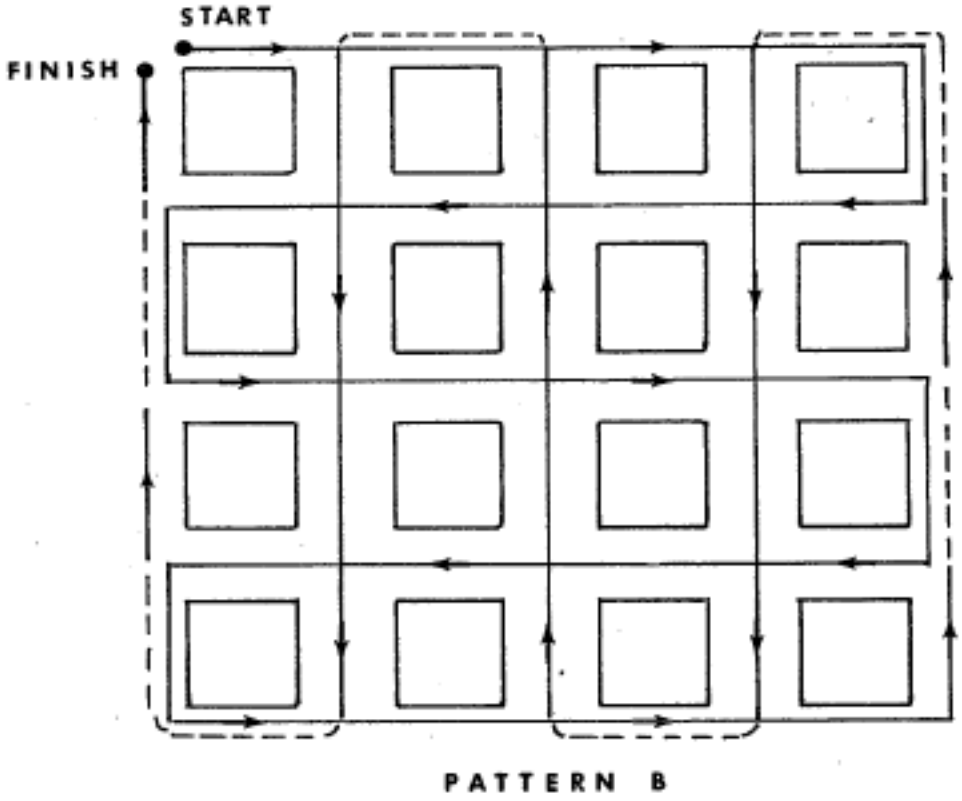
6x8 BLOCKS
ONE LEFT TURN
NO DEAD DISTANCE

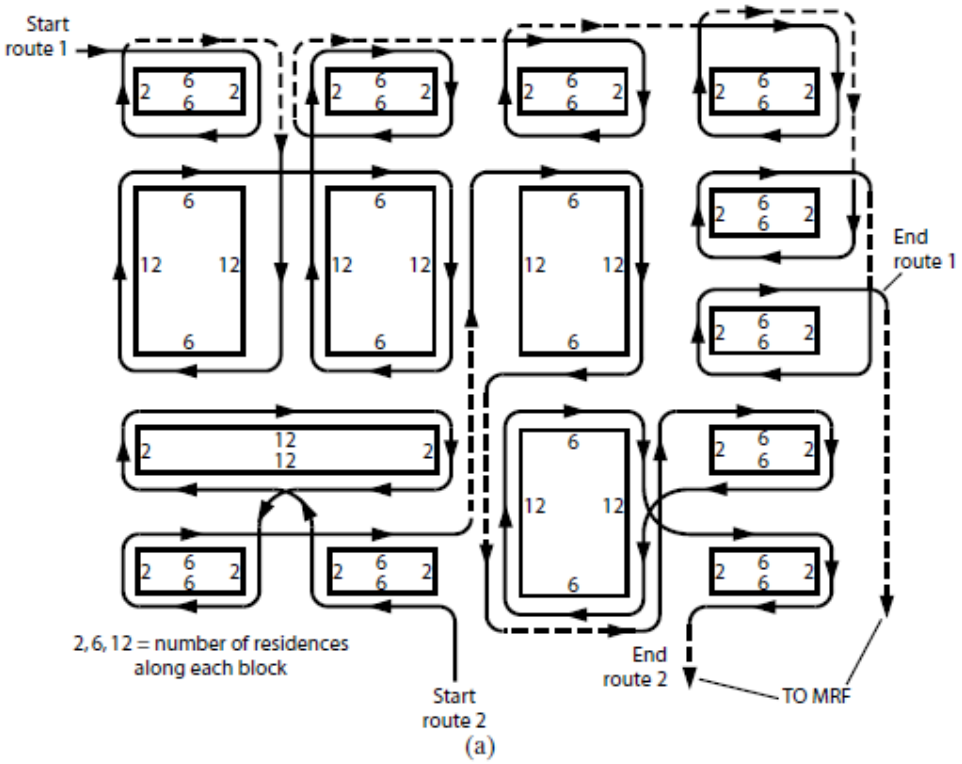
Examples

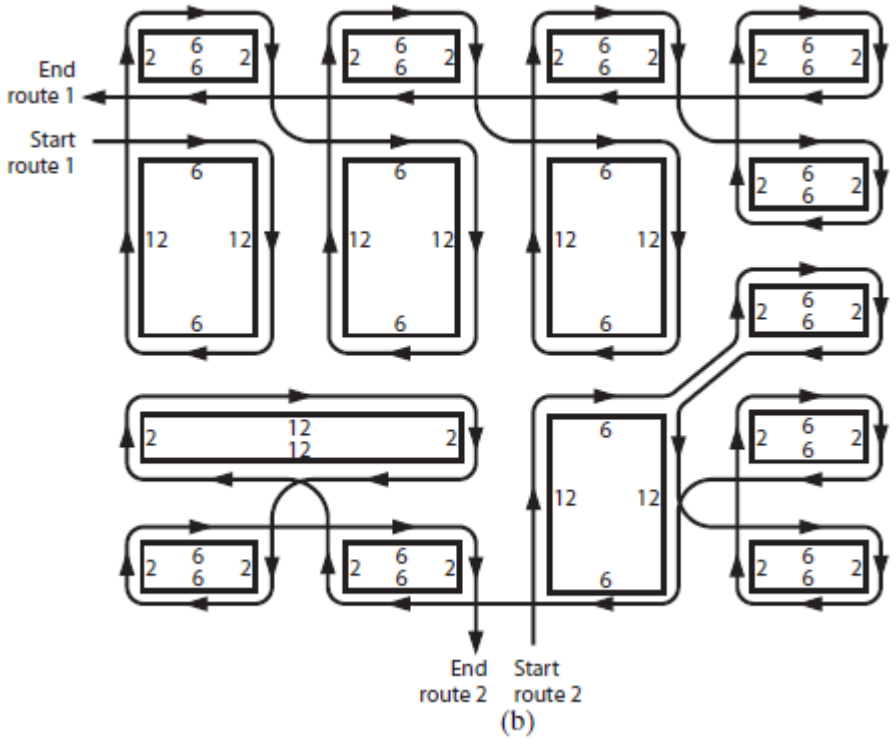
Pattern A: no left turn



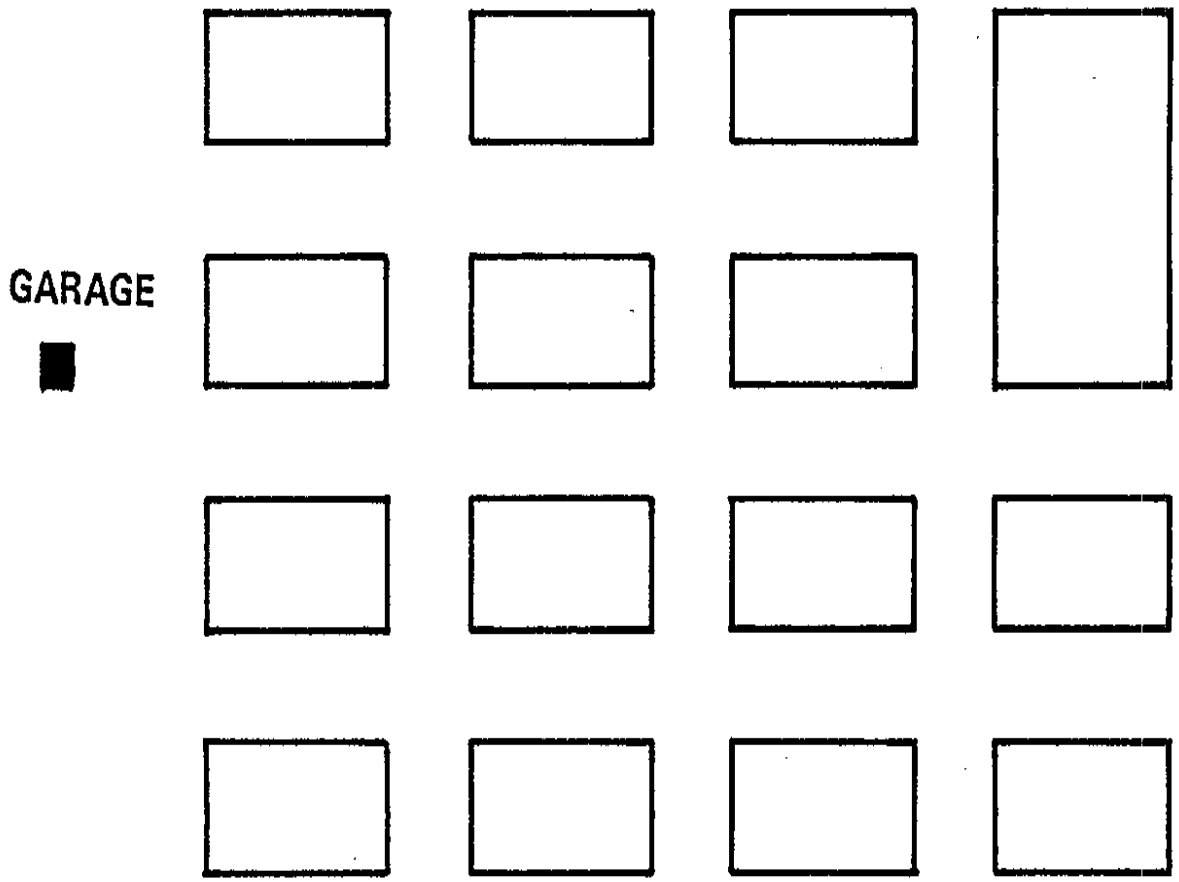
Pattern B: 9 left turns



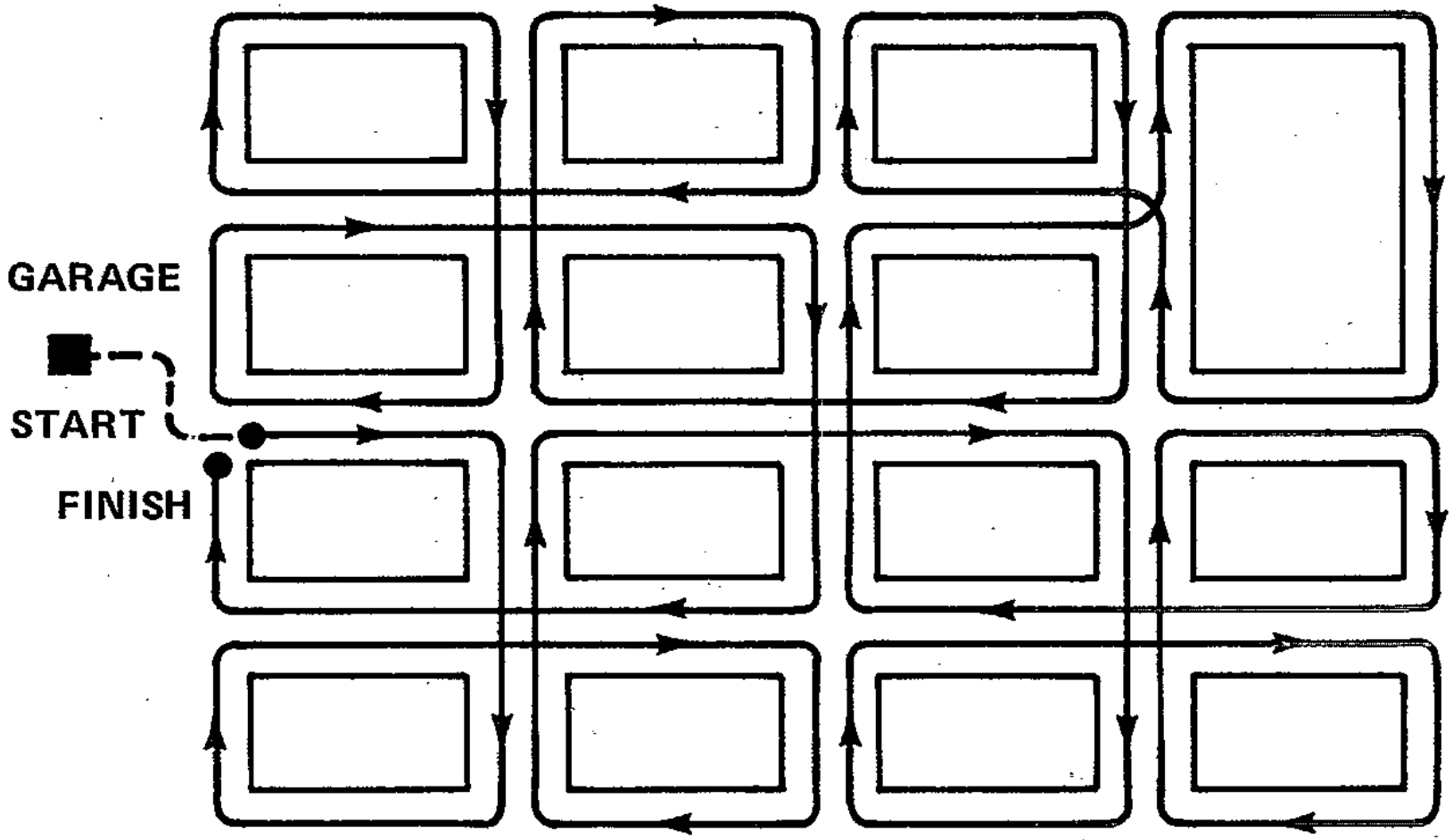

Start
route 1
End
route 1
2, 6, 12 = number of residences
along each block
Start
route 2
End
route 2
TO MRF
(a)


End
route 1
Start
route 1
End
route 2
Start
route 2
(b)

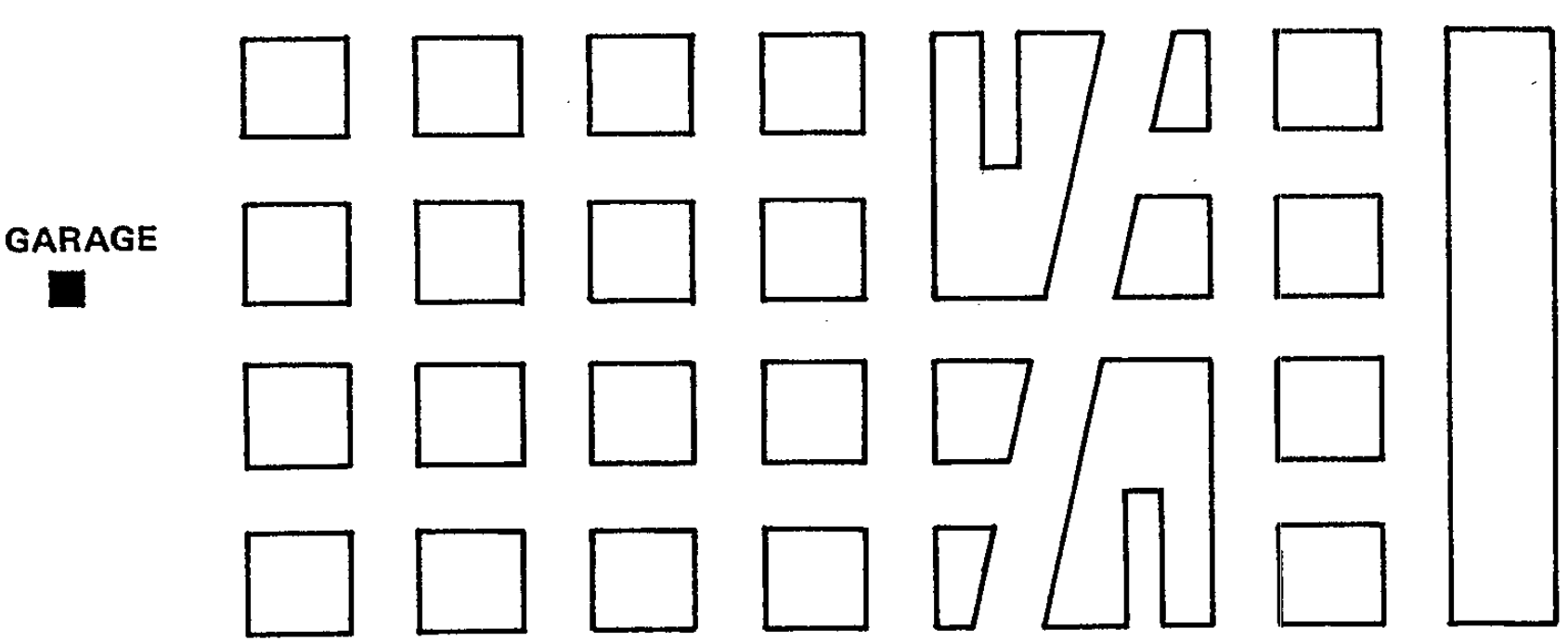
Exercise



Solution



HW



Phase 5: Truck to Disposal

- **Macrorouting:** the routing of a vehicle within its assigned collection zone to the disposal site.