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RESERVE

ECONOMIC ANALYSIS OF SOLID WASTE SYSTEMS FOR RURAL CITIES IN THE SOUTHEAST

J.R. Russell

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ESCS-49

BIBLIOGRAPHIC DATA SHEET	1. Report No. ESCS-49	2.	3. Recipient's Accession No.

4. Title and Subtitle
ECONOMIC ANALYSIS OF SOLID WASTE SYSTEMS FOR RURAL CITIES IN THE SOUTHEAST

5. Report Date March 1979

6.

7. Author(s)
J. R. Russell

8. Performing Organization Rept. No. ESCS-49

9. Performing Organization Name and Address
Natural Resource Economics Division
Economics, Statistics, and Cooperatives Service
U.S. Department of Agriculture
Washington, D.C. 20250

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Address

13. Type of Report & Period Covered Final

14.

15. Supplementary Notes

16. Abstracts

This report provides information on the costs of developing and operating 47 collection and disposal systems in rural cities of less than 10,000 population in the Southeastern United States. The cost components, such as labor and capital requirements, are identified and analyzed in order to help small communities estimate costs of similar solid waste systems in rural areas. There are economies of size in solid waste collection. Excess truck capacity and labor resulted in increased costs for solid waste management. As population density increases, the costs increase.

17. Key Words and Document Analysis. 17a. Descriptors
Capital
Disposal
Economic analysis
Equipment
Expenses
Investments
Manpower
Rural areas
Waste disposal
Waste treatment

17b. Identifiers/Open-Ended Terms
Collection system
Disposal system
Labor use
Rural Southeastern United States
Solid waste management

17c. COSATI Field Group 02-B, 13-B

18. Availability Statement Available from:
NATIONAL TECHNICAL INFORMATION SERVICE, 5285 Port Royal Road, Springfield, Virginia 22161.

19. Security Class (This Report) UNCLASSIFIED

20. Security Class (This Page UNCLASSIFIED

21. No. of Pages

22. Price

HIGHLIGHTS

This study provides information to assist small communities in their solid waste management planning. Conclusions and recommendations are based on the most economical systems observed in a special 1974 survey of a representative sample of 47 towns of less than 10,000 population in the Southeastern United States. Principal conclusions and recommendations include:

1. Total collection costs per ton in 1974 ranged from just under $9 to more than $53 among the 47 towns. Per capita costs were similarly variable, from about $5 up to nearly $30. Towns in the 1,000-3,000 size averaged lower costs than those smaller or larger. Variable costs accounted for 71 to 95 percent of total costs.

2. High-cost collection systems frequently had excess labor and equipment capacity or more costly equipment than needed. Decisions had often been made on equipment size and type without adequate consideration of distance to disposal site, housing density, amount and type of waste at each point, and the amount and cost of available labor.

3. Among the sampled towns of under 2,500 population, the least cost system observed for solid waste collection was a 10-cubic-yard compactor truck with a rear-end loader system, employing one driver and two pickup men.

4. Among the sampled towns of 4,000-6,000 population, the least cost system for waste collection was a rear-end loader/compactor truck used on two shifts per day. Labor requirements generally were two drivers and six pickup men (one and three for each shift).

5. For towns of 6,000-10,000 population, the most efficient collection system found among those sampled was a dumpster with front-end loader to handle commercial waste, in addition to a rear-end loader/compactor. Total labor requirements were generally four drivers and 10 pickup men to run two shifts on each vehicle.

6. Only three of the 47 towns used curbside pickup instead of yard pickup. Although there were too few cases for analysis, labor requirements for curbside pickup appeared to be about one-third lower than for yard pickup.

7. Most of the sampled towns used county-owned landfills and paid for their use. Only seven of the largest towns owned their own disposal sites. In general, it appeared more costly to own a disposal site than to pay for using one.

Washington, D.C. 20250 March 1979

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Economic Analysis of Solid Waste Systems for Rural Cities in the Southeast

J.R. Russell*

INTRODUCTION

The design and management of solid waste systems in large cities and metropolitan areas have received considerable attention and study. Less attention has been given to the waste management problems of smaller communities (less than 10,000). Solid waste management in smaller communities is often more difficult because of small staffs and lower budgets for public services. While most larger cities have full-time staff, small cities generally do not have full-time waste management departments and thus have more difficulty in planning and developing efficient systems.

The Solid Waste Disposal Act of 1965 applies to small cities as well as large areas. Many State and local governments have enacted legislation imposing environmental regulations on the collection and disposal of solid waste. State and local officials and planners are faced with the task of developing solid waste management systems that meet environmental requirements in an economical manner.

Purpose and Objectives

This study provides information to assist rural communities in their waste management planning. It is the second report of a broad study designed to describe and analyze solid waste management systems in rural areas of the Southeastern United States. The first report, Solid Waste Management Systems in the Rural Southeast (AER-333), published in May 1976, described existing systems operating in the rural areas. This report focuses on the costs of solid waste management systems of rural cities in the Southeast with less than 10,000 population. More specifically, the objectives are to:

*Agricultural Economist, Natural Resource Economics Division, Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture.

(1) Identify the costs of operating solid waste systems and determine the effect of various factors on total costs, and

(2) Develop suggestions and guidelines for establishing least cost systems for cities of varying sizes.

Procedure

Rural communities in a four-State area--Georgia, Alabama, South Carolina, and North Carolina--were sampled. The sample was representative of rural areas in the three major geographic regions--mountain, piedmont, and coastal plains. Twenty-five counties were selected from these four States. To insure that the sample included solid waste systems in rural areas, counties containing Census districts with populations exceeding 10,000 were omitted. The sample counties contained 125 cities with population ranging from 102 to 9,700 people.

Data Collection

Completed questionnaires were obtained from 47 small city systems with less than 10,000 population. No system was included that collected solid waste outside the city limits.

Separate questionnaires were used to collect information on solid waste collection systems and waste disposal systems. 1/ Data were collected on the size of the operating unit, management, financing, cost of operation, and other variables dealing with the ownership and operation of collection systems and disposal systems for 1974. Although the actual prices may have changed since the study was done, the cost relationships still hold. Solid waste planners in small cities can revise the budgets included here using local costs and following the procedures outlined.

SOLID WASTE COLLECTION SYSTEMS

Collection systems reported in this study were publically owned and serviced only those areas within the city limits. Most of the systems used similar pickup procedures and equipment. All labor was paid from public funds and service was available for all commercial, residential, and institutional establishments within the city limits. Commercial establishments include businesses such as restaurants and stores. Institutional establishments include hospitals, schools, and similar institutions located in the city. Collection schedules were normally different for homes and for commercial and public units.

1/ Copies of the questionnaire may be obtained by writing to Natural Resource Economics Division, ESCS, U.S. Dept. of Agriculture, Washington, D.C. 20250.

In all cases, the function of the collection systems was to collect waste at the point of generation and to deliver it to a disposal site. No pickup stations or similar transfers were used in any of the systems studied.

Variations in Costs by Population Served

The systems served populations ranging from 213 to 9,700 people. For use in analysis, all observations were divided into three population groups: 1) less than 1,000, 2) 1,000 to 2,999, and 3) 3,000 to 9,700 (see appendix).

For the 16 cities with a population of less than 1,000, total cost per ton of waste collected ranged from a low of $9.68 to a high of $53.61, averaging $23.64 (app. table 1). The variable costs accounted for approximately 85 percent of total cost. The city with the lowest total cost per ton of $9.68 had a variable cost that averaged approximately 71 percent of the total cost. This system was very labor intensive.

Total costs of the 15 cities in the second size group (1,000 to 2,999 population) varied from $11.58 to $30.15, averaging $18.28 per ton (app. table 2). Approximately 73 percent of the high cost unit ($30.15) was accounted for by the variable cost, while the unit with a low total cost per ton of $11.58 had approximately 95 percent of the total cost attributed to variable costs.

The group with the largest population (3,000 to 9,700) had the greatest variation in total costs per ton (app. table 3). The variation of total costs ranged from a low of $8.72 per ton to a high of $46.52, averaging $24.04 per ton. The variable cost for the city with this low total cost accounted for approximately 90 percent of the total cost per ton, and the highest cost of $46.52 had approximately 85 percent accounted for by variable cost.

The average total cost per ton and cost per capita were calculated for each group (table 1). The second group of cities (1,000 to 2,999) had the lowest cost per ton and the lowest per capita cost as well as the lowest average variable and fixed costs per ton.

Table 1--Waste collection costs for three sizes of cities, 1974

Population of cities served	Average population served	Annual waste	Average cost per ton			Average cost per capita
			Fixed	Variable	Total	
	Number	Tons	Dollars			
Less than 1,000	535	571	4.35	19.29	23.64	24.90
1,000 to 2,999	2,057	1,352	3.38	14.90	18.28	11.84
3,000 to 10,000	5,441	3,458	3.58	20.46	24.04	14.04
All cities	2,702	1,178	3.74	18.28	22.02	16.98

Population Served

In order to analyze the effect of population size on costs, collection systems are classed into two groups according to population served: less than 4,000 and 4,000 and over. Thirty-four systems, or 72 percent, served a population of less than 4,000 and only 13 systems served a population between 4,000 and 9,700.

Population is a major factor in estimating quantity of waste production and in evaluating collection and disposal services. However, in many communities industries and public institutions produce large amounts of waste that affect estimates based upon population. In some cities, institutions such as hospitals and schools were not charged for services, but in all cases they were served by the collecting system.

A more detailed breakdown by size of population within each group is used in the final section of this report to analyze operations by size.

Labor Requirements

Labor utilized in operating a collection route varies according to the size of population served, the volume of waste handled, and the type of system. The 34 cities with less than 4,000 population had an average labor force of 3.8 people per system and averaged 6,126 hours of labor per year for collecting solid waste (table 2). The average crew member worked 1,612 hours per year, or about 80 percent of full time. Many of these workers were working full time in their job with their time divided between solid waste collection and other work for the city, such as street cleaning.

Table 2--Size of labor force, man-hours worked, and labor cost for solid waste collection, 47 rural cities in the Southeast, 1974

Item	Unit	Population of cities served	
		Less than 4,000	4,000-10,000
Labor force size:			
Average	Workers	3.8	13.7
Range	do.	2-12	9-20
Total time worked:			
Average	Hours	6,126	26,935
Range	do.	960-23,000	15,360-46,080
Total labor cost:			
Average	Dollars	14,435	66,259
Range	do.	2,400-53,760	40,000-127,000

The 13 collection systems operating in the larger class (4,000 and over) utilized their laborers an average of 1,966 hours per year per member for an average labor force of 13.7 people per system. The larger cities usually used their crew full time for solid waste collection.

The problem of fully utilizing labor occurred most frequently in small cities of 1,000 population and less. A normal pickup crew consists of a driver, two collectors, and a compactor truck. Two collectors are generally necessary for back-door pickup. A two-man crew, driver and collector, is the minimum labor requirement, regardless of the size of the community, for back-door pickup. A crew of two men was the smallest labor force operating in the communities sampled.

The total labor cost for collection systems varied considerably among cities of similar size. Examples of the variations in volume of waste, labor force, type of customers, and total costs for four cities with the same population are presented in table 3. The system with the highest labor cost collected less waste than any of the four systems analyzed and employed the greatest number of employees.

Table 3--Annual labor costs for four systems serving similar size populations in the rural Southeast, 1974

System	Population 1/	Annual waste collected			Total labor force	Total labor cost
		Total	By type of customer: Home	By type of customer: Other		
	Number	Tons	Percent	Percent	Workers	Dollars
A	6,000	1,924	68.1	31.9	16	69,600
B	6,000	3,120	58.3	41.7	9	40,320
C	6,000	4,680	64.1	35.9	12	55,920
D	6,000	2,080	62.5	37.5	12	43,900

1/ Rounded numbers--no system had a population varying by more than 25 from 6,000.

The type of customer from which waste is collected affects the total cost of collection. More labor is used when a larger proportion of waste is collected from homes (table 3). The system with highest labor costs collected 68.1 percent of their total waste from homes. The system with lowest labor costs collected only 58.3 percent of the total waste from homes. This was the general trend from all sampled systems.

Equipment Use and Capacity

Many of the smaller systems used their equipment less than full time with excess capacity. The typical equipment used was compact trucks and "tote" barrels--plastic containers used to deliver waste from home containers to compactor trucks. Annual hours of use varied considerably with the size of population served.

The capacity of vehicles hauling solid waste is an important factor in the development of an economical collection system. Most systems used the same type of compactor trucks but the capacities varied (table 4).

Table 4 presents a comparison of equipment use for the systems serving four different cities with equal population. There is a wide variation in the amount of waste collected and the capacity of trucks handling waste. For example, system A collected the least waste, 1,924 tons of waste per year, yet this system also had trucks with the greatest hauling capacity, 80 cubic yards. The high cost of this capacity is reflected in the fixed annual cost of $12,949. The fixed cost of this unit amounted to 67 percent of the total annual cost. Unit C collected 4,680 tons of waste with 64 cubic yards of capacity and had a fixed cost of $8,365, which represented only 55.7 percent of the total annual equipment cost.

Variations such as those presented in table 4 appeared among many of the systems. Many cities developed their systems rapidly in order to meet Federal and State requirements without giving adequate consideration to costs. In many cases, city officials stated that they had little choice in selecting the best type of vehicle because it was difficult to obtain equipment in a short length of time. They simply purchased what was available in an effort to meet deadlines for having a system designed to meet Federal and State requirements.

Table 4--Annual equipment cost and vehicle capacity for four collection systems serving similar size populations in rural Southeast, 1974

System	Population 1/	Annual waste collected	Total capacity of vehicles	Replacement value of vehicles 2/	Annual fixed cost	Other vehicle cost	Total annual cost
	Number	Tons	Cu. yd.	Dollars			
A	6,000	1,924	80	72,000	12,929	6,350	19,299
B	6,000	3,120	64	47,000	8,160	4,550	12,710
C	6,000	4,680	64	54,000	8,365	6,650	15,015
D	6,000	2,080	77	48,000	8,783	4,950	13,733

1/ Rounded numbers--no system had a population varying by more than 25 from 6,000.
2/ Rounded estimate from questionnaire.

Normally, such factors as distance to disposal site and amount of labor available should be the deciding factors in determining vehicle capacity. There was no indication that either of these really affected the size of truck selected.

DISPOSAL SYSTEMS

Two major types of disposal systems were used by small cities--sanitary landfills and dumps. Since open dumps are no longer acceptable, cities that used dumps were making plans to establish landfills for disposing of solid waste.

Cities normally do not own disposal sites. Only seven of the large cities included in the sample owned their disposal sites. Because of limited data for analysis, disposal costs will not be analyzed.

Labor Requirements

The labor requirements for disposal sites were less important than labor required for collection. In most cases, cities used county-owned landfills and paid fees for use of the landfill. These fees covered labor costs. Usually, only one person was employed at each landfill site.

Equipment Use

The seven larger cities with their own disposal sites maintained equipment for operating these sites. The equipment usually consisted of a bulldozer and, in a few cases, a back hoe or similar equipment. A recommended budget for a disposal system is presented in a later section.

FACTORS AFFECTING COST OF DEVELOPING AND OPERATING A SYSTEM

Investment

A major investment for solid waste systems was the collection vehicles. The average vehicle investment for cities of less than 4,000 was $16,629 while an average investment of $68,231 was required for the larger cities (table 5). Cities of less than 4,000 population owned vehicles ranging in hauling capacity from 8 to 40 cubic yards. A rule of thumb commonly used by planners in 1974 to estimate cost of equipment was $1,000 per cubic yard of capacity. Using this rule of thumb, estimated cost of equipment varied from approximately $8,000 to $40,000 while the actual cost ranged from $7,800 to $36,000.

There was a wide variation in size and cost of collection vehicles within each size category. Many cities in the under 4,000 population group appeared to have excess equipment investment. For example, one city with a population of 500 collected from 120 homes and 60 commercial establishments twice each week. The system used a 16-cubic-yard compactor with a four-man crew. Another city with a population of 3,000 picked up twice per week from 650 houses, 1 industry, 40 commercial establishments, and 2 institutions. This crew worked 6 days per week while the crew for the smaller city (500 population) worked only 2 days per week, and the remainder of the week they

Table 5--Annual equipment cost for solid waste collection systems in 47 rural cities in the Southeast, by population category, 1974

Item	Population of cities served	
	Less than 4,000	4,000-9,700
	Dollars	
Initial equipment investment[1/]:		
Average	16,629	68,231
Range	7,800-36,000	33,000-154,000
Hours used:		
Average	1,739	7,269
Range	520-4,160	4,992-18,020
Fixed cost:		
Average	3,166	12,294
Range	1,212-6,910	5,528-27,534
Variable cost:		
Average	1,859	7,226
Range	1,125-6,512	4,500-18,400
Total cost:		
Average	5,025	19,520
Range	2,484-15,442	11,428-46,382

1/ Replacement value in 1974.

worked on some other job for the city. These types of variation occurred many times in both population groups.

Labor

Labor cost is the largest component of total annual collection costs. It represented 82 percent of the costs for the smaller cities and 84 percent for the larger ones (table 6). Wide variations in labor costs exist, reflecting differences in both hourly wages and number of hours worked. For example, 1,664 hours were utilized in collecting from one city with a population of 500 to pick up 520 tons of waste from 120 homes and 60 commercial establishments on a twice weekly schedule. Another city with 3,000 population utilized an average of 3,576 hours of labor in collecting 884 tons of waste from 650 homes, 1 industry and 40 commercial establishments, and 2 institutions on a twice weekly schedule. Therefore, a city with 6 times the population utilized only about twice the amount of labor. This is an indication of the type of labor use variation that occurred in many cases.

Only three cities reported curbside pickup. This is not enough observation to draw any specific conclusions. However, labor used by this method of pickup service was reduced by approximately 30 percent as compared with yard pickup, with significant impact on total costs.

Table 6--Total annual labor and equipment cost and per capita cost, 47 rural cities in the Southeast, 1974

Population of cities served	Annual equipment cost		Annual labor cost		Equipment and labor cost	
	Total	Per capita	Total	Per capita	Total	Per capita
	Dollars					
Less than 4,000	3,166	2.18	14,435	9.93	17,601	12.11
4,000-10,000	12,294	2.07	66,259	11.17	78,553	11.56

The total operating cost of collecting solid waste averaged $12.11 per capita in cities with population of less than 4,000 and $11.56 per capita in cities of 4,000 and over (table 6).

RECOMMENDED SIZE AND TYPE OF SYSTEM FOR VARIOUS POPULATION SIZES

Most published research and recommendations on waste management are for cities of 25,000 or greater. Cities with population of less than 10,000 are lumped into a single category for analysis. The focus of this report is on cities with populations of less than 10,000 and groups of smaller cities under 10,000. The groupings selected were of populations less than 4,000 and populations from 4,000 and over. The purpose of this section is to identify the practices that could reduce cost in establishing and operating solid waste systems for cities in these two size categories.

This study lacked sufficient data for analyzing some important aspects of a collection system. Such aspects as curb pickup versus back-door pick-up and privately owned systems versus publicly owned systems should be considered when planning a system. Another important factor would be the possibility of small cities and counties to combine resources in developing and operating a collection system. These factors are recognized as important in determining the lowest cost of developing and operating a system, but none of these was presented in the systems included in this study. Therefore, costs presented here are based on actual operating systems rather than synthetic data reflecting optimum systems.

Cities With Less than 4,000 Population

The collection systems represent the major portion of the cost of solid waste management systems for these rural cities. Study results reveal a large variation in the size and type of equipment used as well as in amount of labor. The 34 cities in this group (less than 4,000 population) are divided into two groups in order to present a more detailed cost breakdown (table 7). Recommended size and type of equipment and amount of labor for the two groups of cities by size of population is presented in this

Table 7--Efficient combination of vehicle type, size, and crew for cities under 4,000 population for solid waste collection in the Southeast

Population	Type of pickup	Type of vehicle	Number and size of vehicles	Size of crew
2,500 and less	Back-door	Rear-loading compactor	One 10 cu. yd.	1 driver and 2 men with tote barrel
2,500-4,000	Back-door	Rear-loading compactor	One 15 cu. yd.	1 driver and 2 men with tote barrel

section for use by planners in making decisions. The information derived from the analysis is based on the most economical systems studied for this report.

Collection System

Type and size of equipment. The type and size of equipment to purchase for a specific area is influenced by the following factors: (1) housing density, (2) round-trip time from last pickup to disposal site, (3) amount of waste to be collected at each collection point, and (4) labor wage rates. Small cities consist primarily of single family homes with no large apartment houses. Therefore, a side-loader truck was reported as being more convenient to use in these low-density areas. However, in most of these cities the vehicle also collects waste from commercial establishments and the same type of truck is used for this purpose. It would not be efficient for the city officials to purchase a front-end loader to handle a small amount of commercial waste.

Almost all the cities in the sample used back-door pickup. This type of pickup service always used a tote barrel and was reported as being more convenient with a back-loading truck. The vehicle remains in one position while the loaders use tote barrels to bring waste from the back door to the truck. This was a common practice. Therefore, a rear-loading compactor truck was more commonly used in order to pick up waste from residents as well as commercial customers.

The size of rear-loader trucks ranged in capacity from 6 to 30 cubic yards. Some of these are designed to collect from bulk containers. The commercial establishments tend to be small and do not generate enough waste to justify large dumpster type containers.

The amount of waste generated is approximately 2.5 pounds per capita per day. With a population of 2,500 to 4,000 the daily accumulation of waste would be approximately 2.5 to 5.0 tons per day. A system designed to

pick up waste twice per week could easily handle this volume with a 15-cubic-yard compactor truck and make only one trip to the disposal site after each collection route.

The type of operations discussed here are not recommended as necessarily the most efficient for cities of this size to utilize, but they are the most efficient systems now operating. More research from engineers and other specialists can help planners to design more efficient systems. It is beyond the scope of this study to specifically recommend the most efficient system.

Based on the factors discussed above, a city of under 2,500 population could operate with a 10-cubic-yard capacity compactor truck with a rear-end loader system (table 7).

Amount of labor. The amount of labor needed to operate in any city of less than 4,000 population varies considerably. Collection with only one loader and one driver was reported to be extremely difficult even in the smallest of cities. Normally, two loaders with tote barrels and one driver were employed in the communities of 4,000 population and less. The driver can assist in heavy concentrations of waste such as in commercial areas of these small cities, but he can be of little assistance when picking up in residential areas. Therefore, in this size category a crew of three--one driver and two loaders--was the most efficient crew.

Disposal System

Officials interviewed believed it was not feasible for each community to purchase and maintain a sanitary landfill as required by Federal and State standards. The cost of equipment, land, and labor makes it difficult for small cities to operate their own landfills. All the small cities had agreements with county officials to use county-owned and -operated landfills except the seven that are in the process of converting from dumps to landfills for disposal.

These cities paid a small per capita monthly disposal fee, ranging from 10 cents to 15 cents per month. A city with a population of 4,000 paying 15 cents per capita per month would pay the county $600 per month for solid waste disposal. This is more economical for the cities than purchasing the land and bulldozer, and hiring at least one attendant in order to maintain their own landfills.

City officials felt the cost-sharing arrangement was by far the most economical operation of waste disposal for small cities. Cities with a population of 4,000 and less save money by arranging with the county or larger cities in the area to use their landfill sites for disposal. If no landfill is operating in the county, small cities should consider combining resources to purchase and jointly operate an area landfill.

Annual Costs of Collection

There was a wide variation in the amount of labor, size of vehicle, and frequency of collection in the two size categories. An estimated budget was prepared for a city in the under 2,500 population group and one in the 2,500-4,000 population group (table 8). The costs are based on the

Table 8--Estimated annual total costs for a solid waste collection system for rural cities in the Southeast, 1974

Item	Annual costs[1/]	
	Less than 2,500 population (uses 10-cu.-yd. compactor, initial cost $9,500, used 1,250 hours)	2,500 to 4,000 population (uses 15-cu.-yd. compactor, initial cost $14,000, used 2,000 hours)
	Dollars	
Labor	[2/] 9,984	[3/] 16,900
Fuel and oil	650	1,200
Tires	355	650
Repairs	450	650
Interest and depreciation	1,940	2,345
Tax and insurance	295	375
Miscellaneous	[4/] 350	350
Total	14,024	22,470

1/ Based on 2 pickups per week--back door.
2/ Worked only 24 hours per week.
3/ Worked 40 hours per week.
4/ Includes cost for tote barrels, etc.

most successful collection systems found in operation. The budget designed for cities of less than 2,500 can accommodate any city operating in that size category. To operate this size system for a larger population, the crew would be required to operate more than 3 days per week.

The system designed for the 2,500 to 4,000 size group could easily handle the wastes from cities of 4,000. Recommendations for labor and other variable inputs are based on actual operations, and the most economical operating units were used as a base for these recommendations.

Cities With Population of 4,000 to 10,000

Cities in this category had a population between 4,000 and 9,700. There was considerable variation in collection systems according to routes, crew size, number of pickups, and number and size of vehicles. The few larger cities had a higher proportion of industrial and commercial waste and used night pickups from the commercial areas. No night pickups occurred in small cities.

Cities in this size group were divided into two separate groups (4,000-6,000 and 6,000-10,000) in order to present the more detailed cost data shown in table 9. Only one city in the group of 6,000-10,000 had a population over 9,000. Seven of the 13 cities studied had between 6,000 and 7,000 population. There were five cities in the 4,000-6,000 group, with population ranging from 4,000 to 5,500.

Table 9--Efficient combinations of vehicle type, size, and crew size for 4,000 to 10,000 population for solid waste collection in the Southeast

Population	Type of pickup	Type of vehicle	Number and size of vehicles	Size of crew
4,000-6,000	Back-door	Rear-end loader compactor	Two 20-cu.-yd.	2 drivers 6 pickup men
6,000-10,000	Back-door	Rear-end loader and dumpster with front-end loader	Three 20-cu.-yd. One 20-cu.-yd. dumpster type front-end loader	4 drivers 10 pickup men

Collection Systems

Type and size of equipment. The vehicle size for hauling solid waste was estimated in terms of total cubic yards of hauling capacity. The most commonly used size of hauling capacity for the smaller group (4,000-6,000 population) was 40 cubic yards capacity. This was usually composed of two 20-cubic-yard compactors. These were the rear-loading compactor trucks. The most common operation was with pickup crew and tote barrels bringing the waste from back door to compactor in the street.

Waste management systems in the 4,000 to 10,000 groups normally served about 1,300 homes, 75 commercial establishments, 3 or 4 institutions, and 2 to 3 industrial customers. The large increase in the amount of solid waste handled in this group is due to an increase in commercial and industrial waste. In the 4,000 and less group very little industrial waste was generated. The average amount of waste per capita is approximately 3.0 pounds per day. With a population of 5,000, approximately 15,000 pounds is generated per day. The average city in the under 4,000 group handles approximately 2,700 tons of solid waste per year.

Cities in this size group collected once a week. If two pickups were required, the cost would increase since it would be necessary to double the hauling capacity. It also may be feasible to purchase an extra dumpster truck to handle commercial waste, if waste is collected daily from restaurants, hospitals, and so forth. However, cities in this group have just a few restaurants and other commercial establishments, and daily pickup is not economically feasible unless the city is located in a resort area or some area where there is heavy concentration of motels and restaurants.

The 6,000 to 10,000 population group has different types of collection systems than the 4,000 to 6,000 population group. The average capacity in cubic yards of all compactor trucks used is 80 cubic yards. The higher population changes the need of solid waste handling considerably. Normally, the 80 cubic yards consist of four 20-cubic-yard compactor trucks. Three of these are rear-end loaders and one is a front-end loader with hydraulic pickup system to pick up large dumpster containers (table 10). This is usually operated for commercial pickup, and the pickup service is performed at night. The rear-end loaders are used for home pickup services, and this service is done once a week. The commercial front-end dumpster pickup is utilized 6 days per week. The normal time of operating is approximately 5 hours per day, usually from 7:00 p.m. to midnight.

Table 10--Estimated annual total cost for solid waste collection systems for rural cities in the Southeast, 1974

Item	Annual cost 1/	
	4,000 to 6,000 population with two 20-cu.-yd. compactors, total cost $55,000	6,000 to 10,000 population with three 20-cu.-yd. compactors and one 20-cu.-yd. dump type compactor, total cost $85,000
	Dollars	
Labor 2/	43,000	69,000
Fuel and Oil	1,800	3,200
Tires	700	1,500
Repairs	600	1,400
Interest and depreciation	7,100	10,920
Tax and insurance	750	1,400
Miscellaneous 3/	500	700
Total	54,500	88,120

1/ Based on one pickup from residences per week and daily pickup from commercial establishments.
2/ All crew members for both groups worked 40 hours per week.
3/ Includes cost of tote barrels.

The amount of waste generated by this population group averaged approximately 4.0 pounds per day per capita.

Labor Used. A four-man crew consisting of three pickup men and a truck driver was typically used in towns of 4,000 to 6,000. The total size of the labor force was eight men. Each crew of four operates 5 days per week for 40 hours per week. The drivers are usually paid more than the pickup men. The commercial and industrial customers are all served by the same type of crew. The commercial customers are served daily, and some of the industries are served two to three times per week. In most cases, the larger industries are located outside the city limits and haul their own solid waste to a county landfill or some other designated area for disposal.

The 6,000 to 10,000 population cities normally were using three rear-end loaders for home pickup, and each loader utilized three pickup men and one driver with a total crew of 12. In addition to this, the night crew operated a dumpster type compactor to pick up dumpster containers located in the commerical areas such as restaurants, stores, and motels. This type of vehicle required a crew of two men. However, in many cases waste is placed on top and around the base of many of the containers and the extra crew member assists in cleaning this up before the container is dumped.

The recommended collection crew for this size operation is a total of 14 for the collection systems for eight cities with population of approximately 6,000 to 10,000.

Disposal Systems

Cities in the size group of 4,000 to 6,000 should combine with the county landfill system in order to operate on the most economical budget. The rule of thumb is that 1 acre per year per 10,000 people is sufficient area for a landfill site so this would require only 1/2 acre per year for this size community. The major item of cost would be equipment and labor required to meet Federal standards.

The 6,000 to 10,000 population cities should take a careful look at cost requirements for establishing a disposal system of their own. Many things would have to be taken into consideration. The major item of concern would be: Is there another landfill or some other type of disposal system available? If it is at all possible to cooperate with county government or some other city in establishing a disposal system, in most cases it will be the most economical choice. However, such things as hauling time from waste pickup to the disposal site could be time-consuming and should be considered before making decisions regarding use of such a facility.

In order to establish some guidelines for decisions on disposal site establishment, table 11 presents a budget for estimating cost of developing and operating such a system. These costs are estimates, based on actual costs given by municipal officials in interviews.

Table 11--Average investment and annual total cost of sanitary landfill and facilities to serve a population of 6,000-10,000 for a 10-year period

Item	Cost
Investment costs:	Dollars
One crawler tractor with blade	30,000
One pickup truck (or similar vehicle)	2,500
Operator shed	1,500
Land (20 acres @ $500/acre)	10,000
Fencing and gates	1,500
Access road grading, etc.	7,000
Initial investment	47,500
Annual costs:	
Labor (one man)	7,500
Fuel, oil, and grease	2,500
Repairs and equipment	1,500
Utilities	500
Annual investment cost ($47,500 @ 8 percent, 10-year payment)	7,000
Approximate annual cost of operating landfill	19,000

Appendix table 1--Waste collection costs: Cities with under 1,000 population, 1974

City	Population	Total waste	Fixed cost per ton	Variable cost per ton	Total cost per ton	Total cost per capita
	Number	Tons	Dollars			
1	213	416	2.83	6.85	9.68	18.91
2	250	364	6.85	17.16	24.01	34.97
3	250	364	8.05	45.56	53.61	78.05
4	400	364	6.40	32.47	38.87	35.37
5	405	240	15.15	15.02	30.17	17.88
6	500	520	1.18	16.73	17.91	18.63
7	500	312	1.41	36.47	37.88	23.63
8	500	520	4.80	16.58	21.38	22.23
9	550	312	5.62	12.09	17.71	10.04
10	600	520	2.13	32.31	34.44	29.84
11	650	780	1.13	16.15	17.28	20.74
12	664	676	3.42	7.81	11.23	11.44
13	700	1,040	1.95	10.39	12.34	18.34
14	750	936	1.38	12.06	13.44	16.77
15	775	884	3.24	14.14	17.38	19.82
16	850	884	4.10	16.78	20.88	21.71
Average	535	571	4.35	19.29	23.64	24.90

Appendix table 2--Waste collection costs: Cities with 1,000-2,999 population, 1974

City	Population	Total waste	Fixed cost per ton	Variable cost per ton	Total cost per ton	Total cost per capita
	Number	Tons	Dollars			
1	1,200	1,092	2.12	13.64	15.76	14.34
2	1,300	520	8.26	21.89	30.15	12.06
3	1,500	1,144	2.63	15.47	18.10	13.81
4	1,600	1,352	2.49	12.43	14.92	12.60
5	1,700	1,664	3.12	11.76	14.88	14.56
6	1,900	1,560	1.97	10.77	12.74	10.46
7	2,150	1,040	2.57	15.30	17.87	8.65
8	2,200	1,560	1.91	10.67	12.58	8.92
9	2,300	1,820	2.82	23.41	26.23	20.76
10	2,341	941	8.47	19.75	28.22	11.34
11	2,341	1,080	5.49	13.77	19.26	8.89
12	2,500	1,872	3.60	21.63	25.23	18.89
13	2,500	1,924	1.57	10.01	11.58	8.91
14	2,600	1,560	1.84	10.75	12.59	7.55
15	2,727	1,144	1.83	12.19	14.02	5.88
Average	2,057	1,352	3.38	14.90	18.28	11.84

Appendix table 3--Waste collection costs: Cities with 3,000-10,000 population, 1974

City	Population	Total waste	Fixed cost per ton	Variable cost per ton	Total cost per ton	Total cost per capita
	Number	Tons	Dollars			
1	3,000	884	2.80	13.21	16.01	4.72
2	3,500	3,276	.89	7.83	8.72	8.16
3	3,500	2,600	5.66	24.14	29.80	22.14
4	4,000	1,976	5.80	33.91	39.71	19.61
5	4,400	3,120	2.88	18.49	21.37	15.16
6	4,700	1,664	3.68	29.15	32.83	11.62
7	4,750	2,964	2.63	19.04	21.67	13.52
8	5,000	3,380	2.05	17.96	20.01	13.53
9	6,000	2,080	4.51	23.50	28.01	9.71
10	6,000	3,120	2.94	14.38	17.32	9.01
11	6,000	4,680	2.11	13.37	15.48	12.07
12	6,000	1,924	7.04	39.48	46.52	14.92
13	6,500	4,945	1.78	13.30	15.08	11.47
14	7,000	5,460	5.57	25.54	31.11	24.26
15	7,000	7,540	3.57	18.09	21.66	23.33
16	9,700	5,720	3.43	15.93	19.36	11.42
Average	5,441	3,458	3.58	20.46	24.04	14.04

*U.S. GOVERNMENT PRINTING OFFICE : 1979 0-280-931/ESCS-62

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250

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