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AN ANALYSIS OF THE COSTS OF PROVIDING SOLID WASTE DISPOSAL SERVICES IN SOUTHWEST KANSAS: A MULTI-COUNTY PLAN

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by

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CHAPTER I

INTRODUCTION

The Problem

Controlling the pollution of our environment has become a necessary, never ending process encompassing nearly every sector of our society. The search for new and improved methods in all areas of pollution control continues daily with emphasis on economic, social, and technological concepts. Spiralling increases in population both relatively and absolutely has made pollution control a necessary segment of our soceity.

The nation's public and private expenditures on pollution control are expected to reach $18.3 billion in 1975. Expenditures on air pollution will total $4.7 billion, $5.8 billion will be spent for water pollution, and $7.8 billion will be spent for solid waste disposal. Further estimates show a doubling of that amount by 1985. The 1975 total represents $80 per capita compared to $46 per capita in 1970.[1]

The need for proper solid waste disposal has developed primarily due to the fact that we are a society of consumers. Increasing consumption due to real economic growth and population growth has contributed toward increased solid waste generation. The end of the decade of the sixties left this nation with a population of greater than 200 million people, vast industrial complexes, a more automated agricultural sector, and an

[1]Alfred J. Van Tassel, Our Environment: The Outlook for 1980, (Lexington, Mass.: D.C. Heath and Company, 1973), p. 455-472.

increased standard of living. Solid wastes generated from individuals and communities in the early 1970's exceeded 360 million tons per year. Only roughly one half of that amount is being collected. Agricultural solid waste generation contributes approximately two billion tons annually. Mineral wastes total roughly one billion tons annually. The combined amounts total over 3.3 billion tons of solid wastes annually.[2] Within the next thirty to forty years the population of the nation is expected to double. More than a doubling of solid wastes is expected during the same period due to technological advances in the area of disposable containers.

Collecting, transporting, and disposing of solid waste is already the third greatest financial burden of local governments throughout the United States. Expenditures for solid waste disposal are surpassed only by education and road construction expenditures.[3] The Public Health Service estimates that three billion dollars are spent annually in this area by governments.[4] Despite these large expenditures, the quality of solid waste disposal service remains low. Improper disposal methods, poor collection and storage systems, and other related factors contribute to the low quality of service.

The growth of the urban communities and the decline of the central city have contributed to the demand for action in this area. Although in the past the larger cities have been permitted to transport waste materials outside of their jurisdictional boundaries to the surrounding rural communities, into lakes, or onto the ocean shelves, environmental hazards have

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[2]Ibid.

[3]Ibid.

[4]Ibid.

necessitated legislation to eliminate such practices. The sprawling growth of the urban areas causing increased length of haul by waste collection vehicles and thus increasing costs has become a major concern of the disposal process. The larger urban areas consist of many incorporated cities. Each city is limited by its own geographical and jurisdictional boundaries. In many cases solid wastes are transported from one city to another and thus, political differences have been a factor hindering the solutions to these difficulties.

Economic factors, soaring costs of collection and disposal services, billions of tons of unclaimed waste materials, and inadequate quality of service, contribute to the need for proper solid waste management systems. Whether the system should be publically or privately operated has been discussed to a great extent.

Technology in the area of convenience to the consumers has led to an alarming increase of household refuse. While technology has succeeded in greater convience for the consumers, it has been found wanting for the most part in regard to proper disposal methods. Advances have centered on the disposal of household refuse. Little consideration has been given to agricultural residues, industrial wastes, and other hazardous wastes. Much of these wastes have contributed to the pollution of streams, lakes, and rivers.

The concern for public health provides yet another facet of demand for proper solid waste management. Vector control, a problem created by open dumping and impropRer storage of waste material, is important, especially in the low-income urban areas.

With these growing problems, the need for continued research in these areas is increasing. Along with continued research, laws and regulations have been adopted by the federal, state, and local governments. Initially enacted in the mid-sixties, these laws are far reaching and provide a guide for proper handling of the situation. These laws are primarily aimed toward long range goals due to the fact that some of the needed changes require huge capital outlays which require several years of funding.

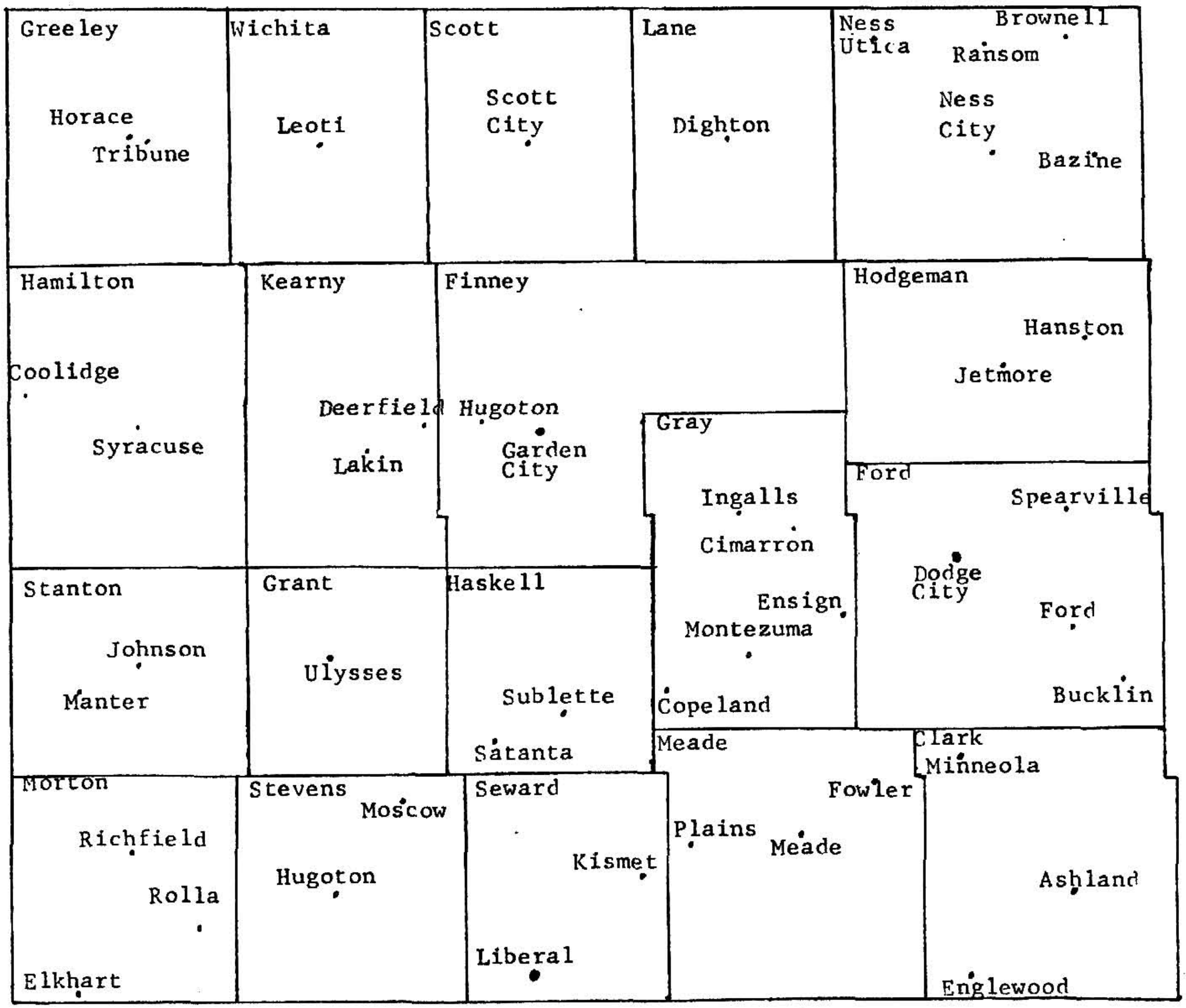
Objectives

The objective of this study is to provide a working relationship among various counties in an effort to develop an adequate solid waste system at a least cost level of operation. The particular area which will be used an example for this study is the Greater Southwest Kansas Region which includes economic development regions 06 and 07. Nineteen counties are included in this region and are shown in figure 1-1. This study will attempt to develop a least cost multi-county disposal system in a sparsely populated area and determine whether an adequate system could be better provided at a reduced per capita cost by a multi-county effort rather than a system of independent county efforts for a twenty year period, 1975-1995.

The primary reason for selecting the particular study area was due to the fact that most areas similar to the Greater Southwest Kansas Region are faced with sparse populations but, due to laws and regulations of the governments and demand from the existing population, are forced to provide various public services. Coupled with the sparse population is a relatively large geographical area necessitating rather long haul distances. Thus, the cost of such public services must be spread over a relatively small population base meaning possible high per capita costs. Also to be included is the quality of service per dollar of expenditures. When outlays for public services decline relative to population changes, the quality of service provided will surely decline. These areas are faced with the dilemma of providing adequate public services at a per capita cost that will not overburden the user. With a sparsely populated county or region, this situation makes solutions for providing adequate services more difficult.

FIGURE 1-1

GREATER SOUTHWEST KANSAS REGION



Most public services provided today are based on county or city jurisdiction. Since many public services demand considerable capital outlays and if the county is faced with a sparse population and one which may be fixed or even declining, high per capita costs and underutilization of equipment will likely occur. If lower per capita costs are realized due to a smaller capital outlay it will probably be at the expense of the quality of service provided. Therefore, what may serve as a solution to the problem is a re-organization of jurisdictional boundaries beyond county or city lines which seeks to provide an adequate quality of service at the least possible cost and maximum utilization of inputs. This multi-county effort proposal for solid waste service attempts to incorporate such ideas into a workable framework. The fact that the nature of solid waste makes this service one of low priority in the eyes of most consumers adds another dimension to the problem of providing proper solid waste services.

The cost of providing solid waste services will be presented in three parts. Initially the amounts of wastes generated must be estimated. Generation of waste materials is measured in tons or cubic yards. Once the volume of wastes have been determined, the costs of providing the collection and transfer service can be estimated. Collection and transfer costs are together the most expensive segments of a solid waste system. Third, disposal costs of the solid wastes collected are estimated. Costs for solid waste services are usually covered by means of a user charge and are often billed on a monthly basis.

For purposes of this study the rural and unincorporated towns of the region will be excluded. According to the Kansas Department of Health, special consideration is given to regions with sparse populations due to high per capita costs. Rural areas and unincorporated towns are not required to participate in the program if each establishment provides proper and adequate disposal of their waste materials. This means that these waste materials shall be handled in a way similar to those rules which govern a sanitary landfill. Since the rural and unincorporated areas in the Greater Southwest Kansas Region are not expected to grow in population throughout the next twenty years, and may by law be exempted from participating, they were excluded from this analysis.

The Laws

The Federal Solid Waste Disposal Act, enacted October 20, 1965, is an attempt to deal with the solid waste pollution threat. The act differs from those of air and water pollution since solid waste pollution is not easily regulated on a national basis. Air and water pollution have virtually no political or jurisdictional boundaries. The very medium of air and water allows for a national effort since each affects the people at large. Solid waste, however, is generated and deposited on a local basis and therefore remains virtually a local problem. The primary interest of the Federal Solid Waste Disposal Act is to assist local governments and interstate agencies in the overall interests of the nation. In its search for evidence, Congress found the following:

1. Technological progress and improvements in methods of manufacturing, packaging, and marketing of products has led to an increase of material discarded by the purchaser.
2. The economic and population growth along with standard of living improvements making necessary destruction of old and construction of new facilities have resulted in an increase of waste materials.
3. Continuing concentration of people in expanding metropolitan and urban areas has led to increased financial, management, and technical problems in the disposal of solid waste material.

4. Inefficient and improper disposal methods have created health hazards, scenic blights, and continued air and water pollution.
5. Unnecessary waste and depletion of natural resources due to an inability to salvage and reuse.
6. While collection and disposal of solid waste should continue to be a function of state and local governments, the problems have become national in scope necessitating Federal action.

From these findings, the purposes of the Act are as follows:[5]

1. Promote the demonstration, construction, and application of solid waste management and recovery systems.
2. Provide technical and financial assistance to state and local governments and interstate agencies in planning and development of solid waste disposal and recovery programs.
3. Promote a national research and development program for improved management and organizational techniques and new and improved methods of collection, disposal, and recovery systems and environmentally safe disposal or nonrecoverable residues.
4. Provide guidelines for solid waste collection, transfer disposal, and recovery systems.
5. Provide training grants in occupations involving the design, operation, and maintenance of solid waste disposal systems.

The Federal Solid Waste Disposal Act was followed in Kansas with the passage of two state acts. The Kansas Air Quality Control Act of 1969, with the latest amendments, took initial effect January 1, 1972. This act forbids all open burning except those being conducted on residential premises containing five or less dwelling units and carried out incidental to normal living. The deadline for total elimination of open burning has been tentatively set for July 31, 1975. Some of these compliances have been required since January, 1973.

The Kansas State Solid Waste Management Act of 1970 became effective January 1, 1972. Under this act, much of the responsibility is again

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[5]U.S. Environmental Protection Agency, Solid Waste Management Office, The Solid Waste Disposal Act, (Washington, D.C.: U.S. Government Printing Office, October, 1965).

handed down to a smaller governing body of either county or city jurisdiction. The involvement of the state was limited to problems of state-wide concern in the form of financial and technical assistance, although enforcement of the law is handled by the Kansas State Department of Health.

The passage of the act has provided the Kansas State Department of Health with the power to enforce the following regulations.[6]

1. Impose requirements on political subdivisions and the private sectors of the solid waste management industry.
2. Adopt rules, regulations, standards, and procedures for solid waste management.
3. Require the planning of solid waste management systems and provide technical and financial assistance in making of solid waste management plans.
4. Provide technical assistance and training for the operational phase of solid waste management.
5. Provide remedies for those affected by violations of solid waste regulations.
6. Prescribe penalties for violations of solid waste regulations.

A timetable has been set by the state in an effort to implement proper solid waste practices prescribed by the various acts. Basically, by January 1, 1971 all counties were to have formed solid waste management committees. On January 1, 1972, the State Solid Waste Management Rules, Regulations, and Standards went into effect. Also during that time the State Department of Health began issuing permits for solid waste disposal sites and facilities. Investigations on industrial, potentially hazardous, junked automobile, and agricultural waste materials were also to begin during 1972. From January 1, 1972 to July 1, 1974, all counties must develop solid waste management plans and receive approval from the State Solid Waste Staff. These plans could include various multi-county efforts. At this time, well over one half of the counties

[6] State of Kansas, Kansas Department of Health, Solid Waste Management and Regulations, (Topeka, Kansas: State Printing Office).

have completed such steps. By July 1, 1976 all disposal sites and facilities in Kansas must have a permit from the Kansas State Department of Health in order to operate.

Although the types of problems which confront society in regard to solid waste pollution can reach far greater depths, the primary problems have been outlined. The various federal, state, and local laws and regulations provide us with a framework to work from in order to combat the increasing problem of solid waste pollution.

CHAPTER II

OVERVIEW AND SOLID WASTE GENERATION IN THE GREATER SOUTHWEST KANSAS REGION

Regional Characteristics

The Greater Southwest Kansas Region is an area organized for the purpose of regional planning. The region comprises 15,685 square miles or 10,153,600 acres.[1] The population in the region in 1972 was 125,934. The population density is slightly over seven persons per square mile, which is significantly lower than the state average of over twenty-seven persons per square mile.[2] The region contains only five per cent of the state population but occupies over nineteen per cent of the total state land area.[3]

The primary industry in the region is agriculture. A considerable amount of the land in the region is irrigated, with most of the irrigation water being obtained from large supplies of underground water.

Natural gas and petroleum are the most important mineral resources in the region. This production represents a significant amount of the total economic production in several counties. The Hugoton gas fields located in the region are the largest producing natural gas fields in the world.

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[1]White, Hamele and Hunsley, Southwest Region Solid Waste Management Plan, (Salina, Kansas), p. 5.

[2]Ibid., p. 6-7.

[3]Ibid.

There are forty-five incorporated cities in the region with a total population of 92,846 in 1972.[4] The largest city in the region according to the 1972 figures was Garden City with a population of 17,530, followed closely by Dodge City at 16,951, and Liberal at 14,001. Garden City, Dodge City, Liberal, Ulysses, Elkhart, Scott City, and Hugoton are second class cities and the remaining cities are third class cities. Garden City, Dodge City, and Liberal have manager forms of government while the other cities all maintain a mayor-council form of government.

The region lies in parts of four physiographic sections including the High Plains, the Dissected High Plains, the Red Hills, and the Arkansas River Lowlands. Over seventy-five per cent of the region is located within the High Plains section, which encompasses a wide belt of high plains that slope gradually eastward to the Central Lowlands. This area is generally characterized by flat to gently rolling uplands. The primary drainage feature in the region is the Arkansas River, which along with its tributaries drain the central and northeast portion of the region.

The region is characterized by low amounts of precipitation, high winds, and abundant sunshine. Average annual precipitation is about eighteen inches. There are wide ranges of temperatures, low relative humidity and generally high wind velocities. Water depths vary from near zero to over 150 feet below the surface. The general availability of ground water in the region is in excess of 1,000 gallons per minute.

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[4]Institute for Social and Environmental Studies, <u>Kansas Statistical Abstract, 1972</u>, (Lawrence, Kansas: University of Kansas, 1972), p. 3.

Over two-thirds of the land in the region is devoted to cropland. The future land use patterns are expected to remain virtually similar to the past. However, the increased demand for energy may cause a need for increased exploration in the gas and oil producing areas and thus, increasing industrialization and changing the land use pattern. The fact that pollution controls have had a major effect on some industrial plants in more densely populated areas has caused some shifts of these facilities to the lesser populated areas which may cause more acreage to be devoted to commercial and industrial use.

In 1970, the combined labor force of the nineteen counties totalled 46,602.[5] Per capita income in 1970 totalled $2820. Median family income in the region ranged from $6,286 to $9,091 during the same period. The median family income for the state in 1970 was $8,693.[6]

Classification of Solid Wastes

There are three main classes of solid waste material: household wastes, commercial wastes, and industrial wastes. A similar, more specific classification of solid wastes is given in table 2-1. For purposes of this study all waste materials except industrial and feedlot wastes were included. It is assumed that due to the nature of these materials they are best handled and disposed of by the individual firms.

Solid Waste Generation Projections

The amount of solid waste generated within a region depends primarily on the population and the level and type of economic activity within the region. Changes in these factors tend to have the greatest immediate

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[5]White, op. cit., pp. 14-15.

[6]Ibid.

TABLE 2-1

CLASSIFICATION OF SOLID WASTES

Name	Content	Source
Garbage	Waste from the preparation, cooking, and serving of food Market refuse, waste from handling, storage and sale of produce and meats	Households Institutions Commercial concerns such as Hotels; Stores, Restaurants Markets, etc.
Combustible	Paper, cardboard, cartons Wood, boxes, excelsior Plastics, rags, cloth, Bedding, leather, rubber Grass, leaves, yard trimmings	
Rubbish Non-Combustible	Metals, tin cans, metal foils Dirt, stones, bricks, ceramics, Crockery Glass, bottles Other mineral refuse	
Ashes	Residue from fires used for cooking and for heating buildings, etc	
Bulky Wastes	Large auto parts, tires, stoves regrigerators, furniture, crates, tree branches, stumps, ets.	
Street Refuse	Street sweepings, dirt, leaves Catch basin dirt Contents of litter receptacles	Streets Sidewalks Alleys Vacant lots, etc.
Dead Animals		
Abandoned vehicles	Automobiles, trucks	
Construction and demolition wastes	Lumber, roofing, and sheathing scraps, rubble, conduit, etc.	Factories Power plants, etc.
Industrial refuse	Industrial processing wastes	
Special wastes	Hazardous wastes: pathological wastes, explosives, radioactive materials Security wastes: confidential documents, etc.	Households, Hospitals, Institutions, Stores, Industry, etc.

TABLE 2-1 - Continued

Name	Content	Source
Animal and Agricultural wastes	Manures, crop residues	Farms, Feedlots
Sewage treatment residues	Coarse screenings, grit, septic tank sludge, dewatered sludge	Sewage Treatment plants, septic tanks

Source: American Public Works Association, Refuse Collection Practice, Public Administration Service, Chicago, Illinois: 1963, p. 15.

impact upon solid waste generation. Increasing technology has given rise to an increasing amount of waste generated per capita each year. Estimates have shown that per capita waste generation is increasing at a rate of one to two per cent annually depending upon the region in question.[7] For purposes of this study it is assumed that per capita waste generation will increase one per cent per capita annually.

According to 1968 survey estimates conducted by the U.S. Department of Health, Education and Welfare, it was estimated urban and industrial wastes, excluding agricultural and mineral wastes generated in the United States averaged ten pounds per capita per day. Of this amount only fifty-one per cent of the amount is being collected and disposed of properly.[8] For Kansas, solid waste collected in the early seventies, excluding agricultural, mineral and automobile waste was estimated to be 4.03 pounds per capita per day collected.[9]

Total population in the state in 1970 exceeded two million. Population in Kansas from 1960-1970 in incorporated areas of 1,000 or more persons increased 16.1 per cent. However, in the same time period the population in the rural areas decreased by 18 per cent. The combination of these two sectors indicates an overall 3.2 per cent increase in population from 1960-1970.

Population and household projections for this analysis from 1970-2000 are based on regional projections developed by the State Population Laboratory

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[7]Bucher and Willis, Seward County Solid Waste Management Plan, (Topeka, Kansas: State Printing Office, 1972), p. 18.

[8]Dean Schreiner; George Muncrief and Bob Davis, Solid Waste Management for Rural Areas: Analysis of Costs and Service Requirements in a Planning Framework, (Stillwater, Oklahoma: Oklahoma Agricultural Experiment Station, 1972), p. 6.

[9]Ibid., p. 5.

which is based upon the 1970 population census.[10] During this time period the total population in the region is expected to decline by approximately 5.2 per cent from 112,340 in 1970 to 106,732 in 2000.[11] Most of this decline will be in the rural areas and unincorporated towns and from towns with less than fifteen hundred population. The larger towns within the region may gain in numbers at the expense of the smaller towns and rural areas. County and city population and household projections were broken down from the regional population projections by computing the percentage of total population held by the various counties and towns from 1960-1970. It is assumed that the pattern of population change which occurred from 1960-1970 in all of the areas will continue for the twenty year period in this study. Once the county projections were determined the same process was incorporated to allocate the county population to the various towns and rural areas. These projections were determined by equation (2-1) presented below.

$$(2\text{-}1) \qquad p_{t+n} = \frac{\%\, p_t}{\%\, p_{t-n}} \times \%\, p_t \times P_{t+n}$$

p_{t+n} - Total projected county population in year t+n

$\%\, p_t$ - Percentage of regional population held by county in year t

$\%\, p_{t-n}$ - Percentage of regional population held by county in year t-n

P_{t+n} - Total projected regional population

The average number of persons per household for the nineteen counties averaged three. Population and household projections for the counties and the respective incorporated cities and towns are shown in table A-1 in Appendix A.

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[10] Population Research Laboratory, Department of Sociology and Anthropology, Regional Population Projections 1980-2010, (Manhattan, Kansas: Kansas State University, 1974).

[11] Ibid.

Based on estimates from the 1968 National Survey of Solid Waste Practices, the estimated household per capita generation for collection and disposal averaged three pounds per capita daily in 1970.[12] Thus with the given projections the estimated annual household tonnage for selected years from 1970-2000 is shown in table 2-2. For purposes of this study the estimated annual solid waste generated was determined by using the average annual generation between 1975-1995.

TABLE 2-2

ANNUAL HOUSEHOLD TONNAGE PROJECTIONS

FOR SELECTED YEARS 1970-2000

Year	Estimated Tonnage[a]
1970	1.64
1972	1.67
1980	1.81
1990	1.97
2000	2.13

Note: [a]Estimated at three persons per household with a one per cent per capita increase in solid waste generation annually. Daily per capita waste generation for the above selected years is 3.00, 3.06, 3.30, 3.60, and 3.90 lbs./capita/day respectively.

Annual household tonnage projections for the respective counties and towns in the region are given in table A-2 of Appendix A for the selected years and as an average of the selected years. Based on these projections, household generation of solid waste will average .036 tons per household per week or 3.42 pounds per capita daily from 1975-1995. These figures are assumed

[12]U.S. Department of Health, Education and Welfare, Public Health Service, 1968 National Survey of Community Solid Waste Practices, (Washington, D.C., 1968).

TABLE 2-3

ANNUAL WASTE GENERATION

PER EMPLOYEE

	Sector	Solid Waste Generation (1,000 lbs./employee)
1.	Farms & Ranches	--
2.	Agricultural Service	7.620
3.	Mining	--
4.	Construction	82.504
5.	Transportation	7.620
6.	Finance and Real Estate	7.620
7.	Utilities	7.620
8.	Food Manufacturing	9.479
9.	Apparel Manufacturing	1.348
10.	Wood and Paper	26.459
11.	Printing and Publishing	16.500
12.	Petroleum Refining	19.394
13.	Leather, Plastic and Rubber	15.066
14.	Concrete Products	5.280
15.	Metal Manufacturing	2.937
16.	Construction Materials	7.620
17.	General Sales	7.620
18.	Food Sales	35.700
19.	Gasoline Service	7.620
20.	Auto Sales	7.620
21.	Clothing Sales	7.620
22.	Furniture Sales	7.620
23.	Eating Establishments	7.620
24.	Lodging and Miscellaneous Retail	7.620
25.	Personal and Business Services	7.620
26.	Professional Services	7.620
27.	Auto Repair	7.620
28.	Recreation	7.620
29.	Wholesale and Retail Trade	7.620
30.	Medical Services	7.620
31.	Households	2.089
32.	Government Employees	7.620

Source: Sectors 8-15 and 18 calculated from: Combustion Engineering, Inc., Technical-Economic Study of Solid Waste Disposal Needs and Practices. Bureau of Solid Waste Management, 1969. Remaining sectors derived from: Golueke, C.G. and P.H. McGauhey. Comprehensive Studies of Solid Waste Management. First and Second Annual Reports. Bureau of Solid Waste Management, 1970.

for all households in the region.

Commercial and institutional waste generation is based on the population and economic activity within the region. The amount of generation per firm is based upon the number of employees for each firm. The estimated annual solid waste generated per employee for each type of establishment is shown in table 2-3.[13] These estimates are based upon solid waste generation studies of west coast commercial and institutional firms. It is estimated that employee generation for the Greater Southwest Kansas Region is approximately one third of those estimates.[14] Employee and firm numbers in the region are based on information supplied by the Employment and Security Division of the Kansas Department of Labor and are supplemented by estimates from the 1972 County Business Patterns from the United States Department of Commerce. It is assumed that a small growth if any, in population will occur from 1975 to 1995 and that the number of firms and their employment will remain virtually constant. The amount of commercial and institutional waste generated will vary from county to county due to different levels of economic activity. It is assumed that all refuse resulting from these establishments will be collected by the public collection systems. These firms along with the number of employees are shown in table A-3 of Appendix A.

There are some waste materials which will be assumed to be handled on a private basis but will be disposed of at the sanitary landfill site. This special waste category includes the general and contract construction

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[13] C.G. Golueke and P.H. McGauhey, Comprehensive Studies of Solid Waste Management, (Washington, D.C.: U.S. Government Printing Office, 1970), p. 26.

[14] Bucher and Willis, op. cit., p. 14.

refuse within the region. The estimated number of construction firms and their employment is shown in table A-4 of Appendix A. Also included in this category are hard to handle materials such as yard wastes and other similar materials. Per capita generation of hard-to-handle waste is estimated at 2.1 pounds per household per week.[15]

The estimated weekly and annual generation of the commercial and institutional firms in the region and the special waste generation is shown in table A-5 of Appendix A. Estimated generation for the combined household, commercial and institutional, and special waste categories is given in table A-6 of Appendix A. The cost of providing solid waste services for the Greater Southwest Kansas Region is based upon these generation estimates.

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[15]Assuming .1 pounds per capita per day.

CHAPTER III

PLANT LOCATION MODEL

Introduction

With the tonnage estimates for each county and town calculated, one must determine the size, number, and location of the disposal facilities which will minimize the total costs of providing solid waste disposal services. Proper disposal of the solid wastes generated has fallen under three categories. The three processing methods are incineration, composting, and sanitary landfilling. Of course, extreme emphasis should be placed on a reclamation program in order to limit needless wasting of resources which in fact could possibly be re-used.

In a region such as the Greater Southwest Kansas Region, Van Tassel states that landfilling is by far the most economical system of disposal available. Sanitary landfilling is suited for areas where abundant land is available. It is also more suited for areas with sparse populations where per capita costs for such services may be significant. Costs per ton for solid waste disposal using the sanitary landfilling method will be over one half less expensive than incineration and slightly less than one half as expensive as composting.[1] Further, incineration and composting

[1] Van Tassel, op. cit., pp. 462-467.

are not complete disposal processes since their residues must ultimately be disposed of at a sanitary landfill or some similarly suitable facility. It is assumed, therefore, in this analysis that the sanitary landfill process will be used.

The Model

In determining the locational pattern for the disposal facilities one must recognize a trade-off between disposal costs and transfer costs. As volume of the disposal facility increases per unit costs of disposal operations decrease. With an increasing volume, equipment and other inputs will be utilized more efficiently. Input costs incurred in the operation will be distributed over greater output. Thus, the per unit cost of output, in this case refuse processed, will decline as the volume of material handled is increased. Such a situation may be referred to as economies of scale. Figure 3-1 depicts this situation for the disposal facilities.[2] However, since the material contributing to increasing plant capacity must be hauled from greater distances, higher transfer costs result. Thus, as plant volume is increased one finds opposing factors retarding a reduction in total costs. Determining the optimal trade-point between transfer and disposal costs is required in order to minimize total costs. By use of the Stollsteimer Model for plant numbers and locations, one can arrive at the optimal number and size of disposal facilities by incorporating these two counter factors in an optimal trade-off. Algebraically this process is shown in equation (3-1). It is assumed that plant processing costs are

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[2]Kenneth C. Clayton and John M Huie, Sanitary Landfill Cost, (West Lafayette, Indiana: Cooperative Extension Service, 1970).

[3]John F. Stollsteimer, "A Working Model for Plant Numbers and Locations," Journal of Farm Economics, Vol. XLV, #3, (August, 1963), 631-645.

independent of plant locations and that economies of scale exist with respect to plant size. With equal factor costs at all potential plant locations, the long run cost function will be invariant with respect to plant location.

$$\text{(3-1)}\quad \text{Minimize } TC_{J,L_k} = \sum_{j=1}^{J} P_j X_j \Big| L_k + \sum_{i=1}^{I} \sum_{j=1}^{J} X_{ij} C_{ij} \Big| L_k$$

with respect to plant numbers ($J \leq L$) and locational pattern

$L_k = 1 \ldots\ldots \binom{L}{K}$

Subject to:

$\sum_{J=1}^{J} X_{ij} = X_i$ = quantity of raw material available at origin i per production period

$\sum_{i=1}^{I} X_{ij} = X_j$ = quantity of material processed at plant j per production period

$\sum_{i=1}^{I} \sum_{j=1}^{J} X_{ij} = X$ = total quantity of raw material produced and processed.

$X_{ij}, X_j \geq 0$ and $C_{ij} > 0$

Where:

TC = Total processing and assembly cost

P_j = Unit processing costs in plant j ($j=1 \ldots J \leq K$) located at L_j

X_{ij} = Quantity of raw material shipped from origin i to plant j located at L_j

C_{ij} = Unit cost of shipping material from origin i to plant j located with respect to L_j

L_k = One locational pattern for J plants among the $\binom{L}{K}$ possible combinations of locations for J plants given L possible locations

L_j = A specific location for an individual plant ($j=1 \ldots J$)

The process of minimizing equation (3-1) with respect to plant numbers (J) and locational pattern $\binom{L}{K}$ can be accomplished in two steps. The first step is to minimize total transfer costs and the second is to determine the processing costs for each combination and number of plants. The first step is solved by use of equation (3-1A).[4]

(3-1A) $\min TTC\ J = \min L_k(X_i{'})\ C_{ij}|L_k$

Where:

$\min TTC$= total transfer cost minimized with respect to plant location for each value of J=1...L

$(X_j{'})$= A (1xI) vector whose entries, X_i, represent the quantities of raw material produced at each of I origins

$C_{ij}|L_k$= A vector whose entries C_{ij} represent minimized unit transfer costs between each origin and a specified set of locations, L_k, for J plants

Plant Location For The Greater Southwest Kansas Region

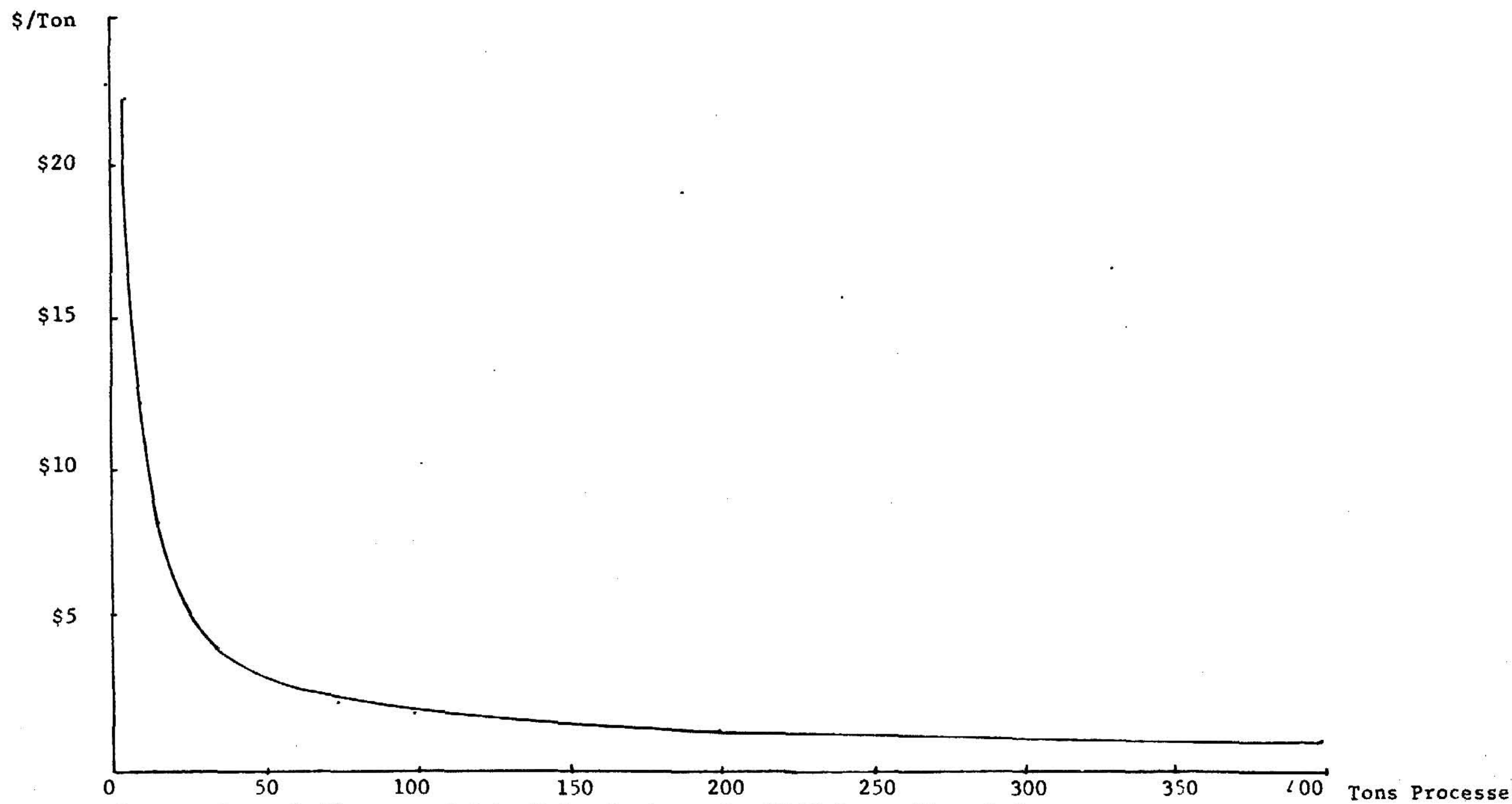
In this analysis six potential locations were considered. The selection of these particular six locations was based upon those counties with the highest tonnage generation. They are listed in order of volume. The locations are Garden City, Dodge City, Liberal, Ulysses, Scott City, and Sublette. The matrix shown in Table 3-1 shows the ton mile cost from the points of origin to the various selected locations. The cost per ton mile estimate is based upon using a forty cubic yard collection vehicle with a refuse weight after compaction of 600 pounds per cubic yard. The capacity of the vehicle is therefore, twelve tons.[5] For example, the weekly transfer cost for Greeley county to the Dodge City Disposal Site would be the cost per ton mile figure, .022 in this case, multiplied by the round trip distance, 170 miles, from Greeley county to Dodge City. This result multiplied by the weekly tonnage in Greeley county, 24 from column X', gives total transfer costs of $144. Transfer

[4]Ibid.

[5]Vehicle capacity estimates were provided by Hobbs Trailers, Fort Worth, Texas.

FIGURE 3-1

DISPOSAL COSTS PER TON



Source: Kenneth Clayton and John Huie, Sanitary Landfill Cost, (West Lafayette, Indiana: Cooperative Extension Service, 1970), p.3.

costs per ton are shown plotted against increasing plant numbers in figure 3-2. The combination of plants listed on the graph are those combinations which produce the least cost for the indicated number of plants.

For a one plant operation, transfer costs are minimized by locating the site near Garden City. If two plants are selected, the least cost combination would be sites at Garden City and Dodge City. Garden City, Dodge City, and Liberal would provide minimum transfer costs for a three plant operation. A site located at Ulysses along with the three previously mentioned sites would minimize transfer costs for a four plant operation. Sites located at Scott City and Sublette respectively, would provide minimum transfer cost for a five and six plant operation.

In order to determine the processing costs for each selected combination of plants and plant numbers, the volume for each plant must first be determined. Segmentation of the area was based upon the minimum transfer costs from the origin to the respective disposal site. The size of each set of combinations is shown in table 3-2. Disposal costs for each selected set of plant numbers and combinations is shown in figure 3-2. Combined transfer and disposal costs are shown in figure 3-3 for each truck capacity selected.[6] The per ton costs for transfer and disposal for varying plant numbers is shown in table 3-3. Assuming that collection costs are constant for varying plant numbers, the combined transfer and disposal costs are minimized at the three plant combination. The optimum plant location and numbers for the Greater Southwest Kansas Region given the previous assumptions, are those plants located in the Garden City, Dodge City, and Liberal areas.

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[6]Cost estimates for the 20 cu. yd. and 30 cu. yd. vehicles used in figure 3-3 were determined similarly to those for the 40 cu. yd. vehicles in Table 3-2.

TABLE 3-1

TRANSFER COST MATRIX

Origin	CFTNM	TRM						X'	Plant Locations[d]					
County	Cost[a] per Ton Mile	Round Trip Mileage from Origin to Disposal Site[b]						Tons[c] per Week	(1) Dodge City	(2) Garden City	(3) Liberal	(4) Ulysses	(5) Scott City	(6) Sublette
		(1)	(2)	(3)	(4)	(5)	(6)		Transfer Costs ($/week) ($C_{ij}$)					
Greeley	.022	170	164	296	174	92	242	24	144	86	156	92	82	206
Wichita	.022	226	124	232	136	48	204	46	228	126	238	138	48	128
Scott	.022	178	72	202	184	6	140	82	320	130	164	332	11	152
Lane	.022	142	104	258	216	48	172	31	96	70	176	146	32	116
Ness	.022	108	160	290	272	110	225	49	116	172	314	294	118	246
Hamilton	.022	204	98	230	108	158	176	37	166	80	186	88	128	142
Kearny	.022	150	44	174	54	116	120	39	130	38	150	46	100	104
Finney	.022	6	106	130	113	72	68	349	814	45	998	860	552	432
Hodgeman	.022	58	130	260	242	160	158	24	30	68	138	128	84	84
Stanton	.022	178	156	172	44	216	110	25	108	86	94	24	110	60
Grant	.022	154	112	128	6	194	66	95	322	234	268	13	384	138
Haskell	.022	100	68	62	66	140	6	54	120	80	74	78	166	7
Gray	.022	56	68	148	142	140	86	59	72	88	192	184	182	112
Ford	.022	106	6	162	142	178	100	393	51	916	1402	1228	1540	864
Clark	.022	98	204	146	224	276	162	37	80	166	118	182	224	132
Meade	.022	84	140	80	156	212	94	63	116	194	112	216	294	130
Seward	.022	162	130	6	128	202	62	303	1080	868	40	854	1348	414
Stevens	.022	166	134	64	56	206	66	59	216	174	84	72	268	86
Morton	.022	232	200	130	122	272	132	48	246	212	138	130	288	140

Note: [a]Includes labor cost and vehicle cost.

[b]It is assumed that each disposal site will be located within a radius of three miles from the town mentioned.

[c]Does not include special waste materials.

[d]Numbers 1-6 in parenthesis refer to the plant locations; i.e. (1) refers to the Dodge City location, etc.

TABLE 3-2

OPTIMUM PLANT LOCATIONS, PLANT SIZES AND MINIMUM TRANSFER COSTS IN RELATION TO PLANT NUMBERS

Number of Plants	Optimum[a] Location Sites	Tonnage Received by Individual Plants (weekly)	Minimized total Transfer Cost (40 cu.yd.	30 cu.yd.	20 cu.yd.)
1	2	2077.00	3833	4712	6440
2	1	691.25	2694	3313	4526
	2	1385.75			
3	1	622.33	1696	2080	2843
	2	882.23			
	3	572.44			
4	1	622.33	1455	1708	2071
	2	726.40			
	3	461.36			
	4	266.91			
5	1	622.33	1216	1418	1781
	2	543.40			
	3	461.36			
	4	266.91			
	5	183.00			
6	1	622.33	1149	1334	1667
	2	543.40			
	3	407.36			
	4	266.91			
	5	183.00			
	6	54.00			

Note: [a]Each number is a code number referring to those sites shown in table 3-2. i.e. For a 1 plant operation, Garden City, referred to in table 3-2 as site number 2, would be the optimum site.

TABLE 3-3

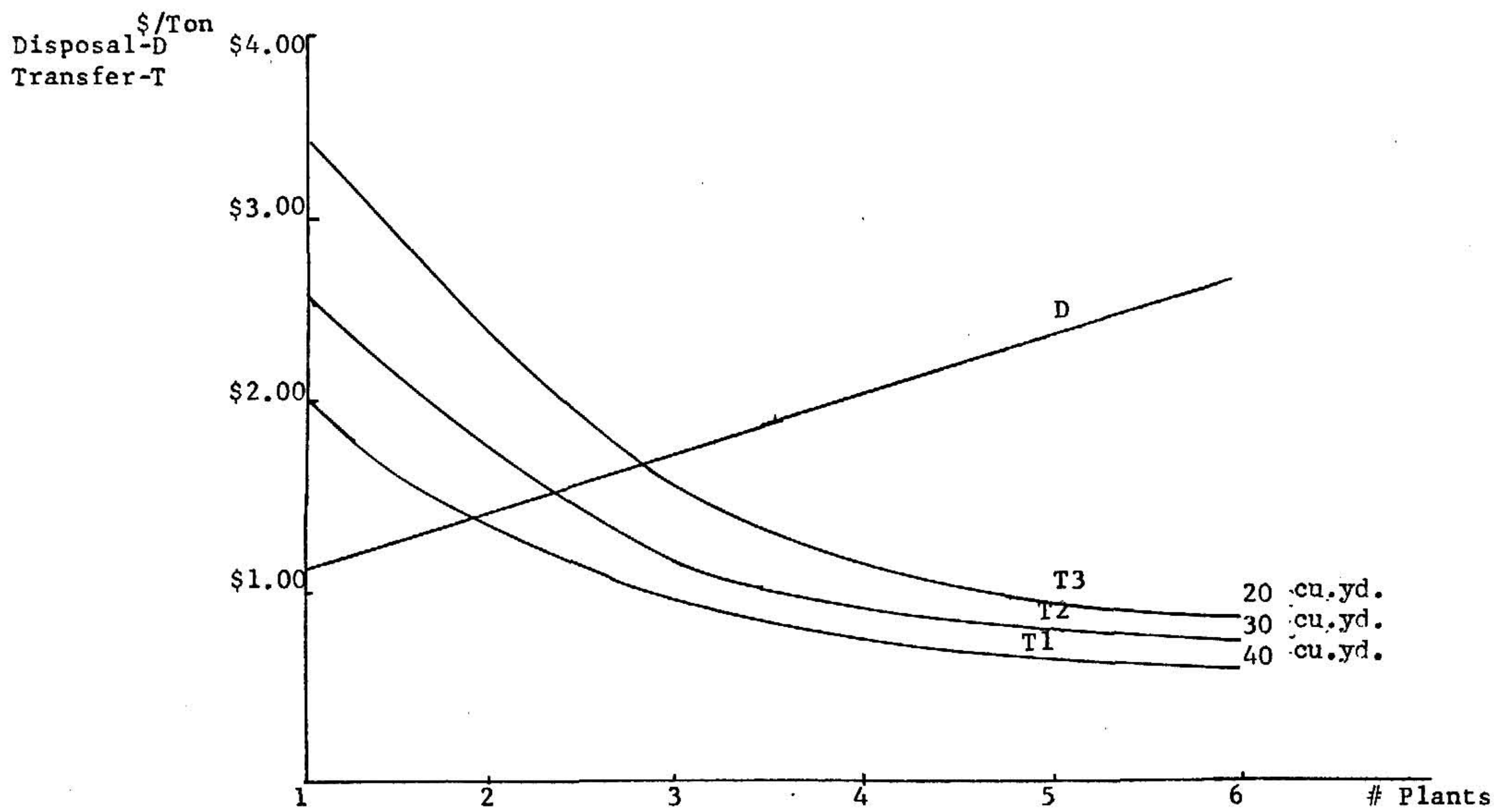
TRANSFER AND DISPOSAL COSTS PER TON

FOR VARYING PLANT NUMBERS AND VEHICLE CAPACITIES

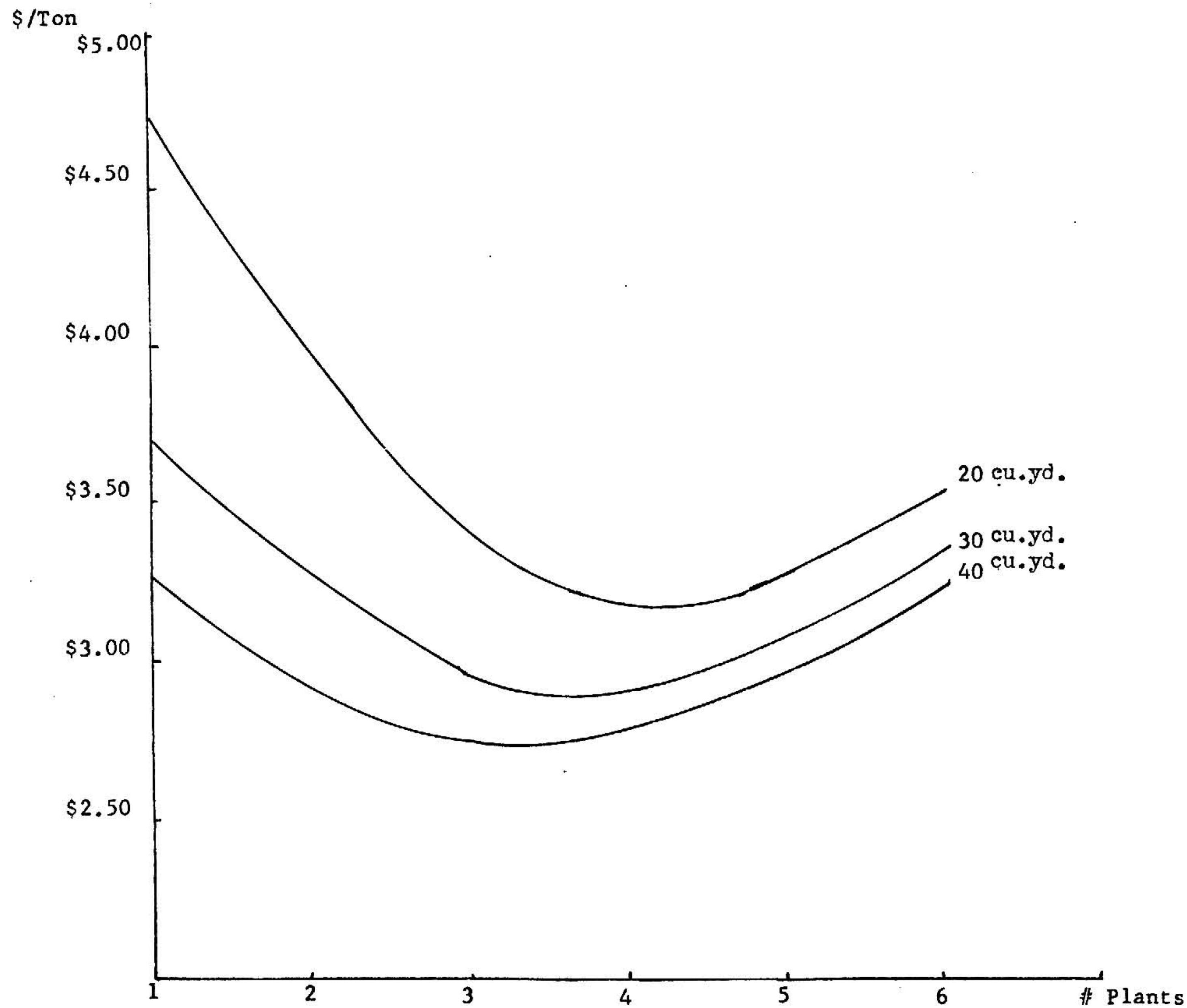
Number of Plants	Transfer Costs[a] (40 cu.yd.	30 cu.yd.	20 cu.yd.)	Disposal Costs	Total Costs (40 cu.yd.	30 cu.yd.	20 cu.yd.)
1	2.10	2.59	3.54	$1.09	3.19	3.68	4.63
2	1.48	1.82	2.50	$1.47	2.95	3.29	3.97
3	.93	1.14	1.56	$1.81	2.74	2.95	3.37
4	.80	.93	1.14	$2.02	2.82	2.92	3.16
5	.66	.78	.98	$2.28	2.94	3.06	3.26
6	.63	.73	.92	$2.62	3.25	3.35	3.54

Note: [a]Includes labor cost.

PER TON TRANSFER AND DISPOSAL COST



COMBINED PER TON TRANSFER AND DISPOSAL COST



CHAPTER IV

COLLECTION AND TRANSFER COSTS

Introduction

The collection and transfer of solid waste materials to a disposal site accounts for approximately eighty per cent of the total cost of providing solid waste disposal services.[1] Costs are difficult to estimate under any set of circumstances. Cost comparisons among and between different systems are almost meaningless unless various factors such as quality and quantity of services provided are determined.

Since most solid waste disposal services are financed by a user charge fee, the model presented in this section for determining collection and transfer costs is broken down to a per collection cost for households and commercial and institutional establishments. Cost per collection consists of collection, transfer and overhead costs.

Collection services can be provided in various forms. The five primary types of collection services provided along with a brief description of each are given in table 4-1. In this analysis, household services will consist of an alley collection system. Commercial and institutional establishments will be collected at a point assumed easily accessible

[1] Robert M. Clark, "Cost of Residential Solid Waste Collection," Journal of Sanitary Engineering Division, American Society of Civil Engineers, Vol. XLVI, (October 1970), 1035-1043.

TABLE 4-1

TYPES OF COLLECTION SERVICES

1. Curb Service-	Homeowner places container at the curb on the day of collection. Homeowner must return container to its proper place after collection.
2. Alley Service-	Containers are stored on the homeowner's property at alley line. Collection is made at that point.
3. Set Out/Set Back-	"Set out" men go house to house taking filled containers to curb line. "Set back" men empty and return the empty containers to homeowner's yard.
4. Set Out Service-	Collector takes container from yard to the curb and empties it. Homeowner returns empty container to yard.
5. Backyard Carry Service-	Collector carries a tote container to the yard and empties the container into it.

Source: U.S. Environmental Protection Agency, Solid Waste Management Office, Guidelines for Local Governments on Solid Waste Management, (Washington, D.C.: U.S. Government Printing Office, 1971).

by the collection vehicle. A particular routing system among and within the cities and towns in each area has not been determined in this analysis. Costs for each colledtion and transfer incorporates the round trip distance from each town to the disposal site. The special waste category is not included in determining collection and transfer costs since it is assumed that these wastes will be transported to the disposal site by a private carrier.

The collection costs are based upon the average generation projections given in table A-6 of Appendix A. It is assumed that collection services will be provided once per week. User charges per month are based on four collections per month. Households are assumed to have two containers per unit and will store the waste material in disposable polyetheline or paper bags and place them within covered metal containers.[3] Households will provide these containers.

The Model

The model for determining collection and transfer costs per collection is given in equation (4-1) below.[4]

$$\text{(4-1)}\quad TCPCOL\,(TRM) = TCPCOL\,(DEN) + (CPTNM \times QSWCOL) \times TRM + \frac{ACRCP \text{---} \sum_{1}^{J} CRCOL(DEN) + (CPTNM \times QSWCOL) \times TRM}{NCOLP}$$

Where:

TCPCOL(TRM)- Total cost per collection as a function of transfer miles.
TCPCOL(DEN)- Total collection cost per collection as a function of density of households.
CPTNM - Cost per ton mile
QSWCOL- Quantity of solid waste collected (tons)
TRM- Transfer miles (round trip)
ACRCP- Alloted crew cost per period
CRCOL(DEN)- Crew cost per collection as a function of density of establishments
NCOLP- Number of collections in period

Equation (4-1A) of equation (4-1) represents the collection cost for each establishment. This cost is listed as a function of the density of the establishments. Collection cost consists of three segments, fixed costs, container costs, and crew costs.

Total fixed costs include the total initial purchase price of the collection vehicles plus the total interest expense. Each vehicle is

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3Recent studies by Ralph Stone and Company indicate that approximately a forty per cent reduction in collection time can be obtained when incorporating a disposable container system into the collection service.

4Dean Schreiner, George Muncrief, and Bob Davis, Solid Waste Management for Rural Areas: Analysis of Costs and Service Requirements in a Planning Framework, (Stillwater, Oklahoma: Oklahoma Agricultural Experiment Station, 1972), p. 17.

assumed to have a five year uesful life with no salvage value. Interest is estimated to be nine per cent annually. Depreciation is based on the straight line method. The specifications and related costs of the collection vehicles assumed for the analysis is given in table 4-2.

$$\text{(4-1A)} \quad TCPCOL(DEN) = FCPCOL + COCCOL + CRCCOL(DEN)$$

$$FCPCOL = \frac{TAFC}{NACOL}$$

$$COCCOL = \frac{TACC}{NACPC \times NCON}$$

$$CRCCOL(DEN) = \frac{CRCPHR}{COLR}$$

Where:

FCPCOL = Fixed cost per collection
COCCOL = Container cost per collection
CRCCOL(DEN) = Crew cost per collection as a function of density of establishments
TAFC = Total annual fixed costs
NACOL = Number of annual collections
TACC = Total annual container cost
NACPC = Number of collections per container per year
NCON = Number of containers
CRCPHR = Crew cost per hour
COLR = Collection rate (number per hour)

Total container cost applies only to the commercial and institutional establishments. Total container costs include the initial purchase expense of the containers plus the total interest expense. Each container is expected to have a useful life of seven years with no salvage value. Interest expense is estimated at nine per cent annually. Depreciation is based upon the straight line method.

Each container is assumed to be of the type which can be automatically loaded into the collection vehicle. For this study it is assumed that each commercial and institutional establishment will have one container.[5]

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[5]A 1:1 relationship between establishments and container numbers has been assumed in this analysis for purposes of simplicity. In some instances, more than one container per establishment will be required while in other instances a combination of establishments may be able to utilize only one container, depending upon the type of establishment.

TABLE 4-2

VEHICLE SPECIFICATIONS

Type	Capacity[a] (tons)	Assumed Velocity (mph)	Purchase Price[b]	Operational Cost Per Hour[c]	Cost Per Ton Mile
39SA	12	40	$22,000	$5.37	.011
33SA FL 45-30	9-10	40	$20,000	$4.96	.014
PO-20-SL FL 45-20	6	40	$16,000	$4.13	.017

Source: Operational Costs provided by Ralph Stone and Company, A Study of Solid Waste Collection Systems, (Washington, D.C.: U.S. Government Printing Office, 1969) p. 101.
Purchase Prices provided by Hobbs Trailers, Ft. Worth, Texas and Galion Products, Inc., Galion, Ohio.

Note: [a]Assuming a weight after compaction of 600 lb./cu.yd.
[b]Current purchase prices.
[c]Weighted average of 40 hrs. collection and haul time and five hours break time per week.

Cost per container is estimated to be $200 for a four cubic yard container.[6] these containers will be provided for each establishment but will be incorporated into the fee in order to retire the initial purchase expense.

The crew cost per collection is based on the density of the establishments. The collection costs are determined by dividing the crew cost per hour by the collection rate. In a recent study, regression analysis was used to estimate the relationship between the collection rate and various explanatory factors.[7] Results of that regression are shown below. The sample was taken from a one-time study of twenty-four bi-weekly routes.

$$\underset{\text{std. errors}}{\text{COLR}} = 66.5028 - \underset{(0.6799)^{*}}{1.2247\ \text{NRM}} + \underset{(0.166)^{***}}{0.788\ \text{DEN}} - \underset{(0.2031)^{*}}{0.1648\ \text{PCOM}}$$

$$R^2 = .71$$
$$n = 24$$

COLR = Collection rate (number per hour)
NRM = Non-route miles (proxy for size of community)
DEN = Density (number of collections per route mile)
PCOM = Per cent commercial (by number of collections)
* = 10% significance level
*** = 1% significance level

The density of collections was assumed to be forty collections per route mile for the residential sectors. It is assumed that there will be two collections made per collection stop and that there are 16.5 non-route miles per vehicle load. For the commercial and institutional establishments it was assumed that there were ten collections per route mile and 16.5 non-route miles per vehicle load.

The collection crew is assumed to consist of one man. The vehicle size is forty cubic yards and is capable of being loaded from either side.

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[6]Bucher and Willis, op. cit., pp. 56-57.

[7]Schreiner, op. cit., p. 11.

Crew costs were estimated to be $10.43 per hour based on a maximum forty-five hour work week. Wages for the crew member are $4.80 per hour. Including overtime, labor costs were estimated to be $5.06 per hour. Each member of each crew will be paid for a minimum of forty hours per week. Break time is estimated to be one hour per day.

Operational costs of the vehicle were estimated to be $5.37 per hour.[8] Vehicle operational costs include all costs of vehicle ownership excluding the initial pruchase expense and interest expense.

Based on a study completed by Ralph Stone and Company, Inc., the time for each household collection assuming a one man crew and alley service is estimated to be 0.7692 minutes.[9] Therefore, for each collection stop a total of 1.54 minutes is estimated to complete the collection services and proceed to the next collection point. Thus, it is assumed that 78 collections will be completed per hour. Commercial and institutional establishment collection stops are estimated at 1.62 minutes per container.[10] Thus, 37 collections per hour are assumed for the commercial and institutional establishments.[11]

With an assumed residential collection rate of 78 and crew cost estimated at $10.43 per hour, the cost per collection is approximately

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[8] Ralph Stone and Company, A Study of Solid Waste Collection Systems Companring One Man Crews With Multi-Man Crews, Washington, D.C.: U.S. Government Printing Office, 1969), p. 101.

[9] Ibid., pp. 76, 100.

[10] Schreiner, op. cit., p. 14.

[11] While the time estimated to complete the various collection services was taken from an in-depth time and motion study by Ralph Stone and Company, a check was made by the author to supplement these estimates on a similar system in Junction City, Kansas. With a three man collection crew, approximately 1,300 collections were made in a six hour period. Thus, each collection required approximately .276 minutes with a three man collection crew.

thirteen cents for each household. Crew cost per collection for the commercial and institutional establishments were estimated to be twenty-eight cents.

Equation (4-1B) of equation (4-1) represents the transfer costs for each establishment. The cost attributable to each establishment is based upon the estimated weight generated per establishment multiplied by the round-trip distance to the disposal site. The cost per transfer mile found by dividing the crew cost per hour by the vehicle velocity, forty miles per hour, is equal to approximately twenty-six cents. The cost per ton mile is found by dividing the cost per transfer mile by the truck capacity, twelve tons. Cost per ton mile is therefore, estimated to equal approximately 2.2 cents. The transfer cost for each establishment is found by multiplying the cost per ton mile figure by the quantity of solid waste collected at the respective establishment. This figure is then multiplied by the round trip distance to the disposal site.[12]

$$(4\text{-}1B) \quad (CPTNM \times QSWCOL) \times TRM$$

$$CPTNM = \frac{CTRM}{TKCAPQ}$$

$$CTRM = \frac{CRCPHR}{VEL}$$

Where:

CTRM = Cost per transfer mile
TKCAPQ = Truck capacity (tons)
VEL = Vehicle velocity in miles per hour

Equation (4-1C) of equation (4-1) represents the overhead ocsts. These costs are basically the difference between alloted and actual crew costs. These costs consist of time spent unloading at the disposal site, longer periods of operation due to inclimate weather, and time for minor

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[12] For purposes of this analysis it is assumed that empty and full load vehicle operational costs are roughly equivalent.

vehicle repairs. Also included is the one hour per day break period for each crew.

$$(4\text{-}1C) \quad \frac{ACRCP - \sum_{1}^{J} CRCOL(DEN) + (CPTNM \times QSWCOL) \times TRM}{NCOLP}$$

$$ACRCP = (CRCPHR \times ACHRS)\ NCRS$$

Where:

ACRCP = Allotted crew cost per period
ACHRS = Allotted crew hours
NCRS = Number of crews in the system

The initial number of crews for each disposal area is determined by estimating the total collection, transfer, and overhead time needed to complete one collection per week. In order to determine the number of crews necessary per disposal area one must divide the estimated time in hours by 45, the allotted number of hours per crew per week. This will determine the number of crews necessary initially. The minimum number of hours recommended for overhead time is two hours per day including the one hour break period.

Collection and Transfer Costs for the Selected Disposal Areas

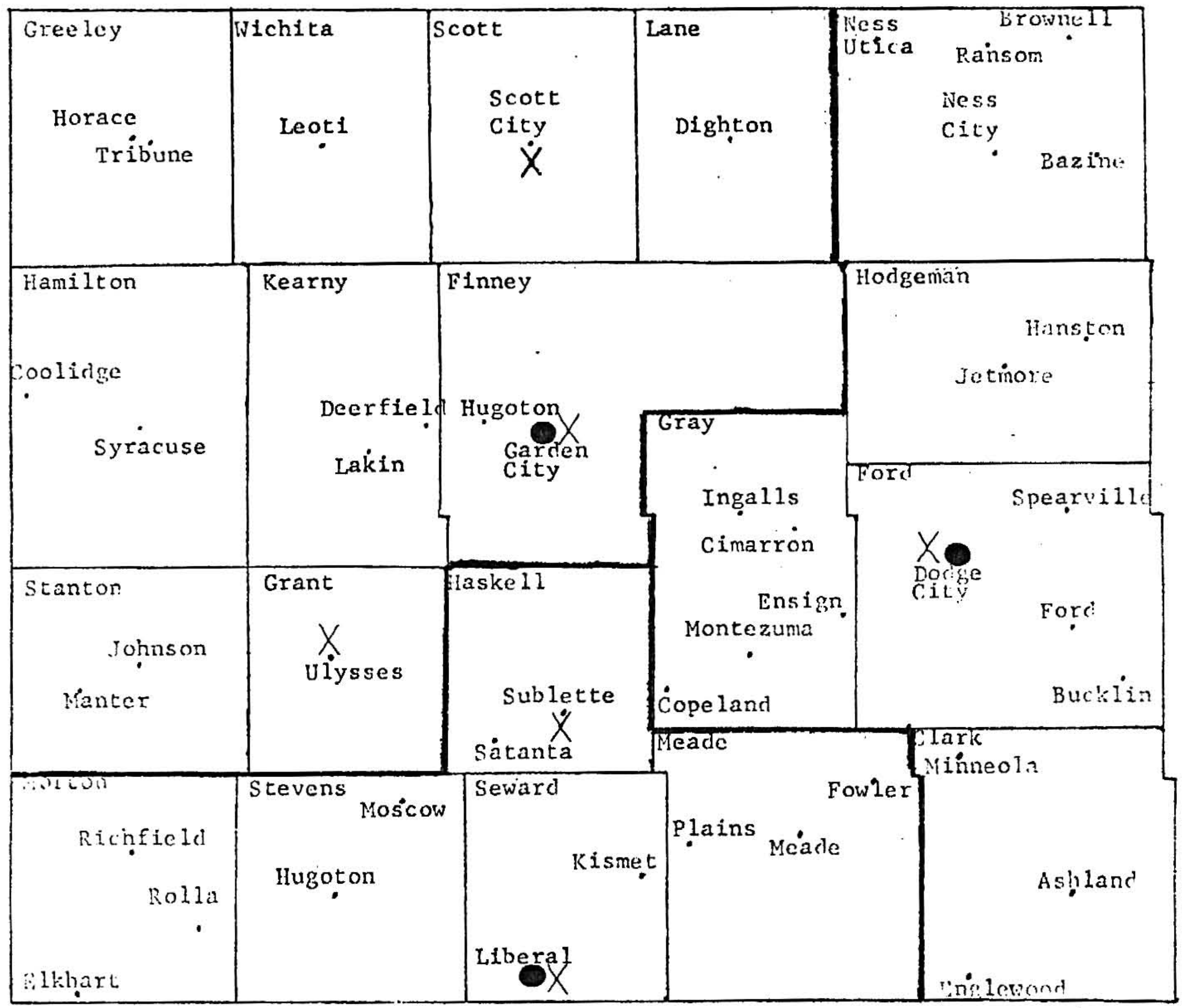
The Garden City disposal region consists of nine counties shown in figure 4-1. Based on the population assumptions, this area includes 11,752 households and a population of 35,199 - excluding the rural and incorporated areas. There are an estimated 886 commercial and institutional establishments in the region. Seven collection crews are needed to provide adequate service to the region. Table 4-3 shows the total annual collection and transfer costs for the Garden City disposal region. Table B-1 of Appendix shows unit costs for collection and transfer services in the Garden City region.

The Dodge City disposal region consists of five counties shown in figure 4-1. Based on the population projections, this area will include 8,316 households with an average population of 25,038, excluding the rural and unincorporated areas. There are an estimated 756 commercial and institutional establishments within the region. Five collection crews are needed to provide adequate service to the area. Table 4-3 shows the total annual collection and transfer costs for the Dodge City area. Table B-1 of Appendix B shows per unit costs for the Dodge City area.

The Liberal disposal system consists of five counties shown in figure 4-1. There are an estimated 8,266 households in this area and a population of 24,798. There are an estimated 622 commercial and institutional establishments within the Liberal area. Five collection crews are needed to provide adequate service to the area. Table 4-3 shows total annual collection and transfer costs for the Liberal area. Table B-1 of Appendix B shows per unit costs for the Liberal area.

FIGURE 4-1

GREATER SOUTHWEST KANSAS SELECTED
DISPOSAL REGIONS



X - Possible Plant Locations

● - Selected Plant Locations

TABLE 4-3

TOTAL COLLECTION AND TRANSFER COST

FOR THE SELECTED DISPOSAL REGIONS

Type	Garden City	Dodge City	Liberal
Vehicle Cost:			
Fixed Purchase 7 x $22,000 Interest 9%	$154,000 five yrs. 41,580 five yrs. $195,580	5 x $22,000 $110,000 29,700 $139,700	5 x $22,000 $110,000 29,700 $139.700
	$39,116 per yr.	$27,940 per yr.	$27,940 per yr.
Container Cost:			
Purchase 886 x $200 Interest 9%	$177,200.00 seven yrs. 64,844.91 $242,044.91	756 x 200 $151,200 54,432 $205,632	632 x 200 $124,400 44,783 $169,183
	$34,577.84 per yr.	$29,376 per yr.	$24,169 per yr.
Crew Cost:			
Vehicle Oper. Cost	45 x 5.37 x 52 x 7 = $87,960 per yr.	45 x 5.37 x 52 x 5 = $62,829 per yr.	45 x 5.37 x 52 x 5 = $62,829 per yr.
Labor	45 x 5.06 x 52 x7 82,882 per yr.	45 x 5.06 x 52 x5 59,202 per yr.	45 x 5.06 x 52 x 5 59,202 per yr.
	$170,843 per yr.	$122,031 per yr.	$122,031 per yr.
TOTAL:	$244,537 per yr.	$179,347 per yr.	$174,140 per yr.

CHAPTER V

THE DISPOSAL SYSTEM

Introduction

The sanitary landfill is presently the only true disposal method available at the present time. Sanitary landfills are often confused with open and uncovered dumps. According to the American Society of Civil Engineers, sanitary landfilling is a method of disposing of refuse on land without creating a nuisance or hazard to public health or safety by utilizing the principles of engineering to confine the refuse to the smallest practical area, to reduce it to the smallest practical volume, and to cover it with a layer of earth at the conclusion of each day's operation, or at such more frequent intervals as may be necessary.[1]

The uses of completed sanitary landfills are numerous. Airport runways for light aircraft, recreational facilities, and residential and commercial facilities have been constructed on completed sites. This is especially important in areas where land is not abundant.

Three primary methods of sanitary landfilling are practiced today. Selection of one type depends upon the topography, location of the water table, and the availability of cover material. Each method and various characteristics of each is listed in table 5-1.

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[1]Robert M. Clark, "Decentralized Solid Waste Collection Facilities," Journal of Sanitary Engineering Division, XCVII, No. SA5 (October, 1972), pp. 563-568.

TABLE 5-1

TYPES OF SANITARY LANDFILLING

Trench Method-	A trench is excavated and the refuse is placed in the trench and is covered with earth excavated from the trench. This method is well suited for flat or gently sloping land where the ground water table is not near the surface.
Area Method-	The area method is preferred when swamps, abandoned quarries, ravines, and other similar areas are suitable for reclamation. The cell is usually square in shape and stockpiling of cover material from other areas is usually necessary.
Ramp Method-	The ramp method is preferred for a sloping area where cover material is available at the site. The refuse material is dumped on the slope and cover material is obtained by excavating just ahead of the active face or from the sides of the landfill site.

Source: Thomas Sorg, Sanitary Landfill Facts, (Washington, D.C.: U.S. Government Printing Office, 1970).

For the disposal areas in this analysis, the trench or ramp method could be used. Both require essentially similar equipment and do not require the hauling of cover material from another area.

Acreage Requirements

The acreage required to accomodate the refuse deposits is determined by the following method:[2]

1. Annual Tonnage x #cu. yd./Ton = Annual cu. yd.

$$\frac{\text{Annual cu. yd.}}{\text{Acre ft./cu. yd.}} = \text{Annual Acre ft.}$$

$$\frac{\text{Annual Acre ft.}}{\text{Depth of fill (ft.)}} = \text{Acres req. Annually}$$

[2]Bucher and Willis, op. cit., p. 47.

2. Supporting Facilities:

30% x Total Acreage Required for Life of Disposal Area

The weight of the refuse after leaving the collection vehicle is estimated to be 600 pounds per cubic yard. After compaction at the landfill site the weight of the refuse is estimated to be 1,000 pounds per cubic yard.[3]

The depth of the disposal cell varies depending upon the ultimate use of the finished site and location of the water tables. The size of the operation and the type of landfill will also be a factor in determining cell depth. Most landfills average from two to fifteen feet in depth excluding the final cover material. In the highly populated areas cell depths are much greater. A cell depth of twelve feet will be assumed for this study.

Acreage requirements must also include areas for supporting facilities. The supporting facilities will include such things as a scale, scalehouse, maintenance and storage facilities, and areas for roadways to and within the disposal area. Acreage required for these supporting facilities is estimated to be thirty per cent of the total acreage required for disposal for the life of the site.[4] Acreage requirements are given for a twenty year period from 1975-1995, the estimated life of the disposal site. Total acreage requirements for each disposal area are shown in table 5-2. The estimated weekly and annual volume of waste to be deposited are taken from table A-6 of Appendix A. The disposal costs are based

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[3]Ibid.

[4]Ibid.

upon the refuse generation figures for both the public collection system and the refuse transported by the private carriers. Each disposal site will operate on a five day week with ten hour days. Each site is assumed to be open 260 days per year.

TABLE 5-2

TOTAL ACREAGE REQUIREMENTS

	Garden City	Dodge City	Liberal
1.	45,875.96 tons/yr.cu.yd. x 2 cu.yd./ton =	32,361 x 2 =	29,766.88 x 2 =
	91,751.92 cu.yd./yr.	64,722.33	59,533.76
	$\frac{91,751.92}{1,613.33^{a}}$ = 56.87 acre ft./yr.	$\frac{64,722.33}{1,613.33}$ = 41.1	$\frac{59,533.76}{1,613.33}$ = 36.9
	$\frac{56.87}{12}$ = 4.74 acres/yr.	$\frac{41.1}{12}$ = 3.42	$\frac{36.9}{12}$ = 3.08
	4.74 x 20 = 94.80 acres/20 yrs.	3.42 x 20 = 68.40	3.08 x 20 = 61.60
2.	94.80 x .30 = 28.44 acres for facilities	68.40 x .30 = 20.52	61.60 x .30 = 18.48
	123 acres/20 yrs.	88 acres/20 yrs.	80 acres/20 yrs.

Note: [a]1 cu. yd. = 1613.33 acre ft.

The Model

Disposal costs are of two types. First is the initial investment expense and second is the yearly operational expense. Total costs of disposal are determined by use of equation (5-1) below.[5]

(5-1) TC = PD + ID + L + E + P + M + AO

Where:

TC = Total annual disposal cost
PD = Annual planning and design cost
ID = Annual initial site development cost
L = Annual land expense
E = Annual owning and operating expense of equipment
P = Annual wages and salaries of personnel
M = Annual site maintenance and development cost
AO = Annual administrative and overhead expense

Initially, planning and design costs are essential for the sanitary landfill to function properly. The expenses which are incorporated into the planning and design cost estimate include those for legal services, consulting assistance, solid waste surveys, geological investigations, and other engineering consultations. The expense for the twenty year period is calculated as follows:

PD = \$72.00 x (V)

V = Daily volume of solid waste (tons)

The planning and design costs for each disposal area is given in table 5-3.

The initial site development costs include all expenses needed to make the site operational. Items required along with the estimated costs for each are summarized in table 5-4. Prices for the various items are based upon current prices.

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[5]Kenneth Clayton and John Huie, Sanitary Landfill Cost, (West Lafayette, Indiana: Cooperative Extension Service, 1970), p. 4

TABLE 5-3

PLANNING AND DESIGN COSTS

FOR DISPOSAL SITES

Garden City	Dodge City	Liberal
\$72.00 x 176.44 tons/day = \$10939.00 for 20 yrs.	\$72.00 x 124.46 = \$7716.50	\$72.00 x 114.48 = \$7097.55
\$10939.00 x .10185[a] = \$1114.13 annually for 20 yrs.	\$7716.50 x .10185 = \$785.97	\$7097.55 x .10185 = \$722.93

Note: [a]Assuming an 8% annuity for 20 years.

Land required for the disposal site is assumed to be leased at a rate of five per cent of market value per acre annually.[6] The market value per acre is estimated to be \$300.00. It is also assumed that this land will be able to be leased for a twenty year period. Thus, the annual land expense for each acre will be fifteen dollars. With the acreage requirements for each area given in table 5-2, the land expense for the Garden City, Dodge City, and Liberal disposal sites will be \$1,830, \$1,320, and \$1,200 annually.

The expense for the disposal equipment generally has a considerable impact upon the total disposal costs. The selection of equipment is usually determined on the basis of manufacturer's specifications and the estimated owning and operating costs. A reduced summary of machine class requirements is listed in table 5-5.[7] Equipment representative of each

[6]Ibid., p. 6

[7]Clayton, Sanitary Landfill Cost, pp. 6,9.

TABLE 5-4

INITIAL SITE DEVELOPMENT COSTS[a]

Fixed Costs:		
	Access roads into landfill	$10,000
	Water Supply	5,000
	Equipment and personnel facility	10,000
	Scale	10,000
	Scalehouse	10,000
	Miscellaneous	10,000
	Total Fixed Costs	$55,000
Variable Costs[b]:		
	Site preparation	$185/acre
	Access roads within landfill	70/acre
	Fencing	50/acre
	Landscaping	40/acre
		$345/acre

	Garden City	Dodge City	Liberal
Fixed Costs:	$55,000 20 yrs.	55,000	55,000
Variable Costs:	122 x 345 = $42,090 20 yrs.	88 x 345 = $30,360	80 x 345 = $27,600
	$97,090 x .10185[c] = $9,888.61 per year	$85,360 x .10185 = $8,693.91 per year	$82,600 x .10185 = $8,412.81 per year

Note: [a]Less than 500 tons/day volume
[b]Variable costs, as stated here, pertain to varying acreage requirements for disposal rather than costs of operation.
[c]Assuming an 8% annuity for 20 years.

machine class is shown in table 5-6.[8] For the Garden City disposal site a D7 Caterpillar of class six is assumed to be used. A D6 Caterpillar of class five is to be used for the Dodge City and Liberal disposal areas.

TABLE 5-5

EQUIPMENT REQUIREMENTS

AND PURCHASE PRICES[a]

Daily Tonnage at Site	Machine Class	Purchase Price
0-49	4	$35,348
50-149	5	$44,006
150-249	6	$56,625
250-499	9	$77,000
500-1199	9&10	$122,100
1200-1224	6&9	$133,635
1225-1624	7&9	$158,293
1625-1700	8&9	$191,966

Note: [a]Prices are based on current purchase prices.

Source: Equipment prices supplied by Foley Tractor Company, Wichita, Kansas.

The operating costs of the landfill equipment is based on the manufacturer's hourly owning and operating cost estimates. These costs include the delivered purchase price, depreciation, tax, insurance, and interest expense. The estimate also includes the costs for fuel, lubricants and supplies, and an annual repair cost estimate. It is assumed that depreciation is determined by the straight line method based on hours of operation. The average depreciation period for equipment of this type is 10,000 hours.[9]

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[8]Ibid.

[9]Ibid., p. 5-6.

In order to determine the annual equipment expense for each of the three disposal areas, an hourly time estimate for equipment operation was calculated. The equipment must perform excavation, spreading, and compacting functions. It is assumed that the equipment will operate at fifty per cent of its predicted capacity. Capacity estimates for each class of equipment and for each function are shown in table 5-7. Time estimates for each function are calculated as follows:[10]

Excavation: (hrs./week)

$$\text{Required Excavation} = \frac{\text{Solid Waste Volume (in pounds per week)}}{\text{Assumed Density of Earth (pounds per cu.yd.)}}$$

$$\text{Hours Required for Excavation} = \frac{\text{Required Excavation (in cu.yd.)}}{\text{Machine Excavation Rate (in cu.yd.per hr.)}}$$

Spreading: (hrs./week)

$$\text{Volume of Solid Waste to be Spread} = \frac{\text{Solid Waste Volume (in pounds per week)}}{\text{600 pounds per cu.yd.}^{a}}$$

$$\text{Hours Required for Spreading} = \frac{\text{Volume of Solid Waste to be Spread (in cu.yds.)}}{\text{Machine Spreading rate(in cu.yd. per hr.)}}$$

(Note: [a]Assumed density after leaving collection vehicle.)

Compacting: (hrs./week)

$$\text{Volume of Solid Waste to be Compacted} = \text{Volume of Solid Waste to be Spread}$$

$$\text{Hours Required for Compacting} = \frac{\text{Volume of Solid Waste to be Compacted}}{\text{Machine Compacting rate}}$$

The annual equipment cost estimates for each of the disposal areas is given in table 5-8.

Personnel requirements will vary with the volume of processing at a sanitary landfill. Personnel costs are the major expense of the disposal process. The personnel requirements for the disposal areas are given in table 5-9.

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[10]Ibid., p. 8.

TABLE 5-6

REPRESENTATIVE MACHINES

FOR EACH CLASS

Machine Class	Caterpillar	International	Allis-Chalmers
1	951	150	6G
2	955	175	7G
3	977	250	12G
4	D5	TD-9	HD6
5	D6	TD-15	HD11
6	D7	TD-25C	HD16
7	D8	-	HD21
8	D9	-	-
9	825	-	-
10	--- Dragline ----		

Source: Kenneth Clayton, Sanitary Landfill Cost, (West Lafayette, Indiana: Cooperative Extension Service, 1970), p.6

TABLE 5-7

CAPACITY ESTIMATES

FOR LANDFILL EQUIPMENT[a]

Machine Class	Assumed Density (lb./cu.yd)	Excavation Capacity[b] (bcy./hr.)[d]	Spreading Capacity[c] (1cy./hr.)[d]	Compacting Capacity[c] (1cy./hr.)[d]
1	1000	56	1200	855
2	1000	76	1200	855
3	950	110	1200	1275
4	800	210	1128	775
5	1000	260	2300	885
6	1000	400	2430	1290
7	1000	560	3000	1440
8	1000	650	4200	1600
9	1300	260	2760	2916
10	--	300	--	--

Note: [a]All capacity estimates are given at 100% efficiency.
[b]Excavation capacities assume a 100-foot-one-way push.
[c]Spreading and compacting capacities assume a 100-foot-one-way push with four passes required.
[d]Notation: bcy. = banked cu.yd; 1cy. = loose cu.yd.

Source: Kenneth Clayton, Sanitary Landfill Cost, (West Lafayette, Indiana: Cooperative Extension Service, 1970). p. 9.

The scaleman-foreman will be in charge of the overall solid waste system. He will oversee the disposal operation and coordinate the collection and routing systems in the particular area.

The function of the laborer is to collect all blowing refuse materials. He will also relocate all temporary catch fences for blowing refuse materials. This function may be provided on a part-time basis depending on disposal volume.

The secretary will record all incoming refuse deposits. The secretary will provide the disposal and collection billing to all establishments in the particular area on an monthly basis.

The annual site maintenance and development expense is intended to cover any maintenance work needed by the disposal facilities. Proper upkeep of all the equipment and facilities is necessary for clean and efficient landfill to exist. This expense item is also meant to cover any costs for cover material which may be needed. Previous estimates indicate that this expense for the life of the facility is equal to twenty per cent of the initial site development expense.[11] Table 5-10 shows the annual expense for each of the disposal areas.

The administrative and overhead expense item includes the utility expenses, expenditures for office supplies, and other administrative requirements. This category is also meant as a contingency fund to meet unexpected minor expenses. Previous studies indicate that the annual expense for administrative and overhead is equal to ten dollars per ton of initial daily tonnage.[12] With daily tonnage estimates at Garden City, Dodge City and Liberal equal to 176.44, 124.60 and 114.80.

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[11] Clayton, Sanitary Landfill Cost, p. 10.

[12] Ibid.

TABLE 5-8

ANNUAL DISPOSAL EQUIPMENT COSTS[c]

	Garden City	Dodge City	Liberal
Excavation:			
	352,880 lbs./wk. / 1,000 lbs./cu.yd.=	248,920 / 1,000=	228,960 / 1,000=
	352.88 cu.yd.req.excv.	248.92	228.96
	352.88 cu.yd.req.excv. / 200 bcy3/hr =	248.92 / 130 =	228.96 / 130 =
	1.76 hrs./day for excavation	1.91 hrs./day for excavation	1.76 hrs./day for excavation
Spreading:			
	352,880 lbs./wk. / 600 lbs./cu.yd.=	248,920 / 600=	228,960 / 600=
	588.13 cu.yd.	414.86	381.60
	588.13 cu.yd. / 1215 1cy./hr.=	414.86 / 1150 =	381.60 / 1150 =
	.484 hrs./day for spreading	.36 hrs./day for spreading	.33 hrs./day for spreading
Compacting:			
	588.13 cu.yd. / 645 lcy./hr. =	448.46 / 442.5 =	381.60 / 442.5 =
	.91 hrs./day for compacting	.94 hrs./day for compacting	.86 hrs./day for compacting
Total Hours Per Day:	3.15	3.21	2.95
Annual Cost:	819[a] hrs./yr. x $13.75/hr.[b]= $11,261.25/yr.	835 x 11.00[b]= $9,185.00/yr.	767 x 11.00[b]= $8,437.00/yr.

Note: [a]Assuming 260 operating days per year.
[b]Operating costs per hour for disposal equipment supplied by Foley Tractor Company, Wichita, Kansas.
[c]An earth scraper would be optional in this instance although may be desired if volume increases. Equipment costs should be adjusted if an earth scraper is included.

TABLE 5-9

PERSONNEL REQUIREMENTS

FOR EACH DISPOSAL AREA

# Required	Function	Hrs./Day	Cost/hr.	Annual Cost
1	Equipment Operator	10	$5.00	$14,300
1	Scaleman-Foreman	10	$5.00	14,300
1	Secretary	8	$3.00	6,240
1	Laborer	8	$4.00	8,320
			Total Annual Cost:	$43,160

The annual expense at each site for this category is eoual to $1764.40, $1244.60 and $144.80 respectively.

TABLE 5-10

ANNUAL SITE MAINTENANCE

AND DEVELOPMENT EXPENSE

Garden City	Dodge City	Liberal
$97,090	$85,360	$82,600
x .20	x .20	x .20
$19,418.00 for 20 yrs.	$17,072.00 for 20 yrs.	$16,520.00 for 20 yrs.
$970.90 annually	$853.60 annually	$826.00 annually

The total annual disposal cost for each area is given in table 5-11. Table B-1 of Appendix B gives per unit disposal costs for each establishment in each town in the respective disposal area.

With collection and transfer costs and disposal costs determined for each of the disposal areas, the user fees can be allocated to each establishment. Table B-2 of Appendix B shows projected monthly user fees for households and commercial and institutional establishments in the Greater Southwest Kansas Region.

TABLE 5-11

TOTAL ANNUAL DISPOSAL COSTS

	Garden City	Dodge City	Liberal
Planning and Designing	$1114.13	785.97	722.93
Initial Site Development	9888.61	8693.91	8412.81
Land	1830.00	1320.00	1200.00
Equipment	11261.25	9185.00	8750.00
Personnel	43160.00	43160.00	43160.00
Annual Site Maintenance and Development	970.00	853.60	826.00
Administration and Overhead	1764.40	1244.60	1144.80
TOTAL:	$69,989.29	$65,243.08	$63,903.54

Charges for disposal of materials transported by private firms and individuals may need to be treated on a slightly different basis. If the carrier is hauling a significant amount of waste material, a tonnage charge may still prove practical. However, since wastes transported by private individuals may be so small in volume, a charge based on tonnage may prove impractical. A charge based on a per vehicle basis may be more suited for this type of situation. These charges will be, in most instances, somewhat above the actual per ton costs of disposal but should not be so high as to discourage such deposits.

CHAPTER VI

RESULTS AND CONCLUSIONS

The results of this analysis indicate that a multi-county system of providing solid waste disposal services may be useful for the Greater Southwest Kansas Region and for other similar areas. Per capita costs for solid waste services provided by a multi-county system tend to indicate lower costs than those of recent, similar studies of individual county efforts within the region. The primary reasons for lower costs in a multi-county system is due to better utilization of equipment and facilities.

Better utilization of equipment may result if facilities are open for longer time periods. Larger, more efficient collection and disposal equipment is being introduced to increase the quality and lower the cost of operations. A multi-county system may also require less total land to be taken out of production when comparing such a system to a group of single county efforts.

There are however, alternatives which may exist and should also be studied. The establishment of small transfer stations within various counties throughout a particular region to receive the solid wastes from collection vehicles of surrounding communities, is one such alternative. The waste material is then compacted and loaded into a more efficient long-haul transport vehicle and taken to a larger, single disposal site. This could be an advantage to the private haulers in that they could deposit waste materials at the transfer station rather than transport the material to the more distant disposal site.

Another alternative could be the movement of disposal equipment among various disposal areas in different counties or towns. The fact that some counties or towns may not require a site to be open an entire week, would make such a system possible. Thus, while counties may each have a disposal site, sharing of disposal equipment may be possible. Again, waste materials would be hauled a shorter distance and users who may want to haul some materials themselves, will be nearer to the disposal site in most instances. There are however, a greater number of advantages and disadvantages to such a system and should be studied in greater depth.

An off-setting factor to a low cost system is loss of quality of service. While a multi-county effort may provide lower costs than that of a single county effort, some advantages may be lost. As was mentioned, with a multi-county effort, most users will be further from a disposal area. Thus, private haul, which may be required from time to time by various users, may be more expensive and impractical. Factors such as these should be considered before a final decision on a particular system is made.

A multi-county effort, if planned and operated correctly, should be able to provide an adequate and more economical service for the nineteen southwest Kansas counties. Such a system, if implemented, could be a great step toward combining other public services under a multi-county effort. While such efforts may, at present, be totally voluntary they may be entirely necessary in the future in order to provide adequate public services at a cost which will not overburden the users.

APPENDIX

TABLE A-1

ACTUAL AND PROJECTED POPULATION AND HOUSEHOLDS

1960 - 2000[a]

County-Town	1960 Pop.	1960 HH	1970 Pop.	1970 HH	1972 Pop.	1972 HH	1980 Pop.	1980 HH	1990 Pop.	1990 HH	2000 Pop.	2000 HH	Avg.[b] 1970 - 2000 Pop.	Avg.[b] 1970 - 2000 HH
Garden City Site														
Greeley	1320	440	1150	383	1379	460	845	281	853	384	818	273	1068	356
Tribune	1116	373	1013	338	1195	398	777	259	784	261	752	251	903	301
Horace	204	68	137	45	184	62	68	22	69	23	66	22	105	35
Wichita	1426	475	1916	639	2405	802	2287	762	2305	768	2216	739	2226	742
Leoti	1426	475	1916	639	2405	802	2287	762	2305	768	2216	739	2226	742
Scott	3539	1180	4001	1333	4391	1464	4163	1388	4196	1399	4033	1345	4185	1386
Scott City	3539	1180	4001	1333	4391	1464	4163	1388	4196	1399	4033	1345	4185	1386
Lane	1568	523	1540	513	1696	565	1306	435	1316	439	1265	422	1425	475
Dighton	1568	523	1540	513	1696	565	1306	435	1316	439	1265	422	1425	475
Hamilton	2033	678	1822	607	2028	676	1478	492	1489	496	1431	477	1650	550
Syracuse	1914	638	1720	573	1932	644	1392	464	1403	468	1348	449	1560	520
Coolidge	119	40	102	34	96	32	86	28	86	28	83	28	90	30
Kearny	1815	605	2044	681	2263	754	2151	684	2067	690	1986	662	2082	694
Lakin	1352	451	1570	523	1765	588	1646	549	1659	553	1594	531	1647	549
Deerfield	463	154	474	158	498	166	405	135	408	136	392	131	435	145
Finney	11,816	3939	15,062	5020	17,992	6097	17,726	5909	17,866	5955	17,173	5724	17,223	5741
Garden City	11,546	3849	14,790	4930	17,530	5843	17,517	5889	17,656	5885	16,971	5657	16,953	5651
Holcomb	270	90	272	90	462	154	209	70	210	70	202	67	270	90
Grant	3071	1024	3779	1260	4389	1463	4258	1419	4292	1431	4126	1375	4170	1390
Ulysses	3071	1024	3779	1260	4389	1463	4258	1419	4292	1431	4126	1375	4170	1390

TABLE A-1 - Continued

County-Town	1960		1970		1972		1980		1990		2000		Avg. 1970 - 2000	
	Pop.	HH	Pop.	HH	Pop.	HH	Pop.	HH	Pop.	HH	Pop.	HH	Pop.	HH
Stanton	1035	345	1257	420	1376	461	1333	444	1335	445	1237	430	1320	440
Johnson	823	274	1038	346	1145	382	1155	385	1156	385	1118	373	1122	374
Manter	212	71	219	73	231	77	178	59	179	60	179	57	198	66
Dodge City Site														
Ness	2972	991	2953	985	2939	979	2743	914	2641	880	2424	808	2739	913
Ness City	1632	544	1756	585	1804	601	1710	570	1646	549	1511	504	1686	562
Ransom	413	138	416	139	395	132	397	132	383	127	351	117	387	129
Bazine	454	151	386	129	391	130	318	106	305	121	281	93	348	116
Brownell	133	45	98	33	84	38	80	27	77	26	70	23	249	83
Utica	336	112	297	99	265	88	238	79	230	77	211	70	249	83
Hodgeman	1286	429	1218	406	1338	446	1090	363	1049	349	964	321	1131	377
Jetmore	994	331	936	312	1035	345	812	271	782	260	718	239	855	285
Hanston	292	29	282	94	303	101	278	92	267	89	246	82	276	92
Gray	2273	758	2703	901	2925	975	2965	988	2854	952	2619	873	2814	938
Cimarron	1048	349	1373	458	1427	476	1682	561	1618	539	1485	495	1518	506
Ingalls	186	62	235	78	289	96	266	89	256	85	235	78	255	85
Ensign	258	86	237	79	238	79	177	59	170	57	156	52	195	65
Montezuma	514	171	606	202	678	226	575	192	554	185	508	170	585	195
Copeland	267	89	252	84	293	98	265	88	256	86	235	78	261	87
Clark	2212	737	2072	691	2008	669	1833	611	1765	588	1618	540	1860	620
Ashland	1320	440	1244	415	1215	405	1090	364	1050	350	963	321	1113	371
Minneola	630	210	670	223	662	221	673	224	648	216	594	198	648	216
Englewood	262	87	158	53	131	47	70	23	67	22	61	21	99	33
Ford	14,149	4806	15,882	5294	18,966	6322	16,592	5531	15,970	5305	14,657	4886	16,404	5468
Dodge City	12,788	4263	14,127	4709	16,951	5650	15,189	5063	14,620	4873	13,419	4473	14,862	4954
Spearville	603	201	738	246	814	271	701	294	675	225	620	207	747	249
Ford	253	84	246	82	289	96	234	78	225	75	206	68	240	80
Bucklin	775	258	771	257	912	304	468	156	450	150	412	137	603	201

TABLE A-1 - Continued

County-Town	1960 Pop.	1960 HH	1970 Pop.	1970 HH	1972 Pop.	1972 HH	1980 Pop.	1980 HH	1990 Pop.	1990 HH	2000 Pop.	2000 HH	Avg. 1970 - 2000 Pop.	Avg. 1970 - 2000 HH
Liberal Site														
Meade	3428	1143	3338	1114	3582	1194	3054	1018	2939	962	2697	899	3111	1037
Meade	1920	640	1899	633	2033	678	1799	600	1731	577	1589	530	1812	604
Fowler	733	244	588	196	600	200	460	153	443	148	406	135	498	166
Plains	775	258	857	285	949	265	795	265	765	255	702	234	813	271
Seward	14,104	4701	13,765	4588	14,325	4755	13,148	4383	13,253	4318	12,736	4246	13,446	4482
Liberal	13,935	4645	13,471	4490	14,011	4670	12,995	4332	13,099	4367	12,588	4196	13,233	4411
Kismet	169	56	294	98	316	105	153	51	154	51	148	50	213	71
Stevens	3045	1015	2967	989	3280	1093	2602	867	2624	875	2522	841	2799	933
Hugoton	2820	940	2739	913	3058	1019	2419	806	2439	813	2344	781	2598	866
Moscow	225	75	228	76	222	74	183	61	185	61	178	59	201	67
Morton	2382	794	2571	857	2863	954	2457	800	2477	726	2381	794	2478	826
Elkhart	1828	609	2089	697	2374	791	2111	704	2128	709	2145	682	2151	717
Richfield	114	38	82	27	108	36	35	12	35	12	34	11	60	20
Rolla	440	147	400	133	381	127	311	104	314	105	302	101	342	114
Haskell	1763	588	2369	790	2701	900	3118	1039	3143	1047	3021	1007	2871	957
Sublette	1063	354	1208	403	1423	474	1289	430	1299	433	1249	416	1296	432
Satanta	700	234	1161	387	1278	426	1829	609	1844	614	1772	591	1575	525

Footnotes to TABLE A-1

[a]In this table and all following tables, figures may not add due to rounding.

[b]Average population and household figures are based on an average of the projections for the selected years 1970-2000.

TABLE A-2

PROJECTED ANNUAL HOUSEHOLD TONNAGE FOR COUNTIES AND

INCORPORATED TOWNS IN GREATER SOUTHWEST KANSAS

County - Town		1970	1972	Years 1980	1990	2000
Garden City Site						
Greeley		629	770	509	769	604
	Tribune	556	667	470	523	555
	Horace	73	103	40	46	49
Wichita		1049	1344	1382	1538	1634
	Leoti	1049	1344	1382	1538	1634
Scott		2189	2453	2518	2802	2974
	Scott City	2189	2453	2518	2802	2974
Lane		843	947	789	879	933
	Dighton	843	947	789	879	933
Hamilton		997	1133	892	993	1054
	Syracuse	941	1079	843	937	993
	Coolidge	56	54	50	56	61
Kearny		1118	1263	1241	1382	1463
	Laken	859	985	995	1107	1174
	Deerfield	259	278	246	273	290
Finney		8245	10,215	10,718	11,927	12,655
	Garden City	8097	9790	9776	11,788	12,507
	Holcomb	148	258	127	140	148
Grant		2069	2451	2574	2866	3040
	Ulysses	2069	2451	2574	2866	3040
Stanton		690	772	805	891	951
	Johnson	568	640	698	771	825
	Manter	120	129	107	120	126
Dodge City Site						
Ness		1618	1640	1658	1763	1786
	Ness City	961	1007	1033	1100	1114
	Ransom	228	221	239	254	259
	Bazine	212	218	192	242	206
	Brownell	54	47	49	52	51
	Utica	163	147	144	154	155

TABLE A-2 - Continued

County - Town		1970	1972	Years 1980	1990	2000
Hodgeman		667	747	658	699	710
	Jetmore	512	578	492	521	528
	Hanston	154	169	167	178	181
Gray		1480	1634	1792	1907	1930
	Cimarron	752	797	1018	1080	1094
	Ingalls	128	161	161	170	172
	Ensign	130	132	107	114	115
	Montezuma	332	379	348	370	376
	Copeland	138	164	160	172	172
Clark		1135	1121	1108	1178	1194
	Ashland	682	678	660	701	710
	Minneola	366	370	406	433	438
	Englewood	87	74	42	44	46
Ford		8695	10,592	10,033	10,626	10,803
	Dodge City	7734	9467	9184	9761	9890
	Spearville	404	454	533	451	458
	Ford	135	161	141	150	150
	Bucklin	422	509	283	300	303
Liberal Site						
Meade		1830	2000	1847	1927	1988
	Meade	1040	1136	1088	1156	1172
	Fowler	322	335	277	296	298
	Plains	468	529	481	511	517
Seward		7536	8000	7951	8849	9388
	Liberal	7375	7824	7858	8747	9278
	Kismet	161	176	92	102	110
Stevens		1624	1831	1573	1753	1859
	Hugoton	1500	1707	1462	1628	1727
	Moscow	125	124	111	122	130
Morton		1408	1598	1451	1454	1755
	Elkhart	1145	1325	1277	1420	1508
	Richfield	44	60	22	24	24
	Rolla	218	213	187	210	223
Haskell		1297	1508	1885	2097	2226
	Sublette	662	794	780	867	919
	Satanta	636	714	1105	1230	1307

TABLE A-3

COMMERCIAL AND INSTITUTIONAL ESTABLISHMENTS AND EMPLOYMENT

1975 - 1995

County-Town	Mfg.		Transp. & Pub. Util.		Wholesale		Retail		Finance		Services		Govt. Inst.		Total	
	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.
Garden City Site																
Greeley	2	25	1	50	5	25	20	100	6	25	10	50	4	150	48	425
Tribune	2	25	1	50	5	25	16	80	5	21	9	45	3	120	42	366
Horace	0	0	0	0	0	0	4	20	1	4	1	5	1	30	6	59
Wichita	2	25	1	25	9	50	26	225	4	25	11	100	5	200	58	700
Leoti	2	25	1	25	9	50	26	225	4	25	11	100	5	200	58	700
Scott	2	25	9	125	15	75	48	375	7	25	35	225	9	200	125	1150
Scott City	2	25	9	125	15	75	48	375	7	25	35	225	9	200	125	1150
Lane	3	25	2	25	6	50	17	125	4	25	12	75	7	200	51	525
Dighton	3	25	2	25	6	50	17	125	4	25	12	75	7	200	51	525
Hamilton	0	0	1	25	4	25	26	150	7	50	20	175	5	225	66	650
Syracuse	0	0	1	25	4	25	21	122	6	45	20	175	5	225	60	617
Coolidge	0	0	0	0	0	0	5	28	1	5	0	0	0	0	6	33
Kearny	1	3	1	75	4	25	18	100	4	25	10	75	6	225	44	528
Lakin	1	3	1	75	3	20	14	69	3	20	8	60	4	165	34	412
Deerfield	0	0	0	0	1	5	4	31	1	5	2	15	2	60	10	116
Finney	25	750	13	400	42	325	127	1475	27	200	110	975	22	1075	336	5200
Garden City	25	750	13	400	41	315	122	1404	25	185	106	945	21	1045	355	5044
Holcomb	0	0	0	0	1	10	5	71	2	15	4	30	1	30	11	156
Grant	6	200	4	225	6	50	42	400	6	50	31	325	8	350	123	1250
Ulysses	6	200	4	225	6	50	41	400	6	50	31	325	8	350	123	1250
Stanton	0	0	1	7	6	75	6	75	2	10	5	25	5	150	25	342
Johnson	0	0	0	7	6	75	4	50	1	6	5	25	4	121	21	284
Manter	0	0	0	0	0	0	2	25	1	4	0	0	1	29	4	58

TABLE A-3 - Continued

County-Town	Mfg.		Transp. & Pub. Util.		Wholesale		Retail		Finance		Services		Govt. Inst.		Total	
	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firm	Emp.
Dodge City Site																
Ness	3	25	4	50	6	25	49	249	9	60	21	175	13	250	105	825
Ness City	3	25	4	50	4	16	31	126	5	28	11	116	7	142	65	503
Ransom	0	0	0	0	1	4	6	34	1	11	4	25	2	43	14	118
Bazine	0	0	0	0	1	5	6	34	1	11	4	25	2	43	14	117
Brownell	0	0	0	0	0	0	2	21	1	4	0	0	0	0	3	25
Utica	0	0	0	0	0	0	4	25	1	6	2	9	2	22	9	62
Hodgeman	0	0	2	25	4	25	15	75	4	25	7	25	6	225	38	450
Jetmore	0	0	2	25	3	20	11	60	3	20	5	20	5	180	29	325
Hanston	0	0	0	0	1	5	4	15	1	5	2	5	1	45	9	125
Gray	1	25	2	25	4	25	32	225	14	175	11	175	10	300	77	950
Cimarron	1	25	2	25	4	25	15	115	6	78	6	88	4	150	38	506
Ingalls	0	0	0	0	0	0	3	20	2	20	1	20	1	35	7	95
Ensign	0	0	0	0	0	0	3	20	1	17	1	17	1	20	6	74
Montezuma	0	0	0	0	0	0	7	50	4	44	4	34	3	75	18	203
Copeland	0	0	0	0	0	0	4	20	1	16	2	16	1	20	8	72
Clark	2	10	2	50	3	25	30	125	6	50	18	75	6	250	67	585
Ashland	2	10	2	50	2	20	18	69	3	27	10	41	3	150	40	367
Minneola	0	0	0	0	1	5	9	44	2	17	7	30	3	100	22	196
Englewood	0	0	0	0	0	0	3	12	1	6	1	4	0	0	5	22
Ford	33	1225	24	800	30	300	186	2000	48	275	124	1350	25	1325	470	7275
Dodge City	31	1115	22	720	27	270	168	1800	44	248	113	1215	23	1210	428	6518
Spearville	1	55	1	40	1	10	9	75	1	10	5	60	1	58	19	308
Ford	0	0	0	0	0	0	2	50	1	5	2	20	0	0	5	75
Bucklin	1	55	1	40	2	20	8	75	2	12	4	55	1	57	19	314
Liberal Site																
Meade	5	75	2	100	8	50	34	250	8	25	22	200	7	275	86	975
Meade	5	75	2	100	6	30	17	150	5	14	10	120	4	165	49	654
Fowler	0	0	0	0	1	10	7	40	1	4	5	30	1	40	15	124
Plains	0	0	0	0	1	10	10	60	2	7	7	50	2	70	22	197

TABLE A-3 - Continued

County-Town	Mfg.		Transp. & Pub. Util.		Wholesale		Retail		Finance		Services		Govt. Inst.		Total	
	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.	#Firms	Emp.
Seward	9	925	25	850	39	275	117	1425	29	200	97	725	18	850	335	5250
Liberal	9	925	25	850	39	275	114	1396	27	196	95	711	18	850	328	5203
Kismet	0	0	0	0	0	0	3	29	2	4	2	14	0	0	7	47
Stevens	2	25	6	225	10	50	37	225	3	25	22	250	5	275	85	975
Hugoton	2	25	6	225	10	50	32	214	2	15	21	140	5	275	79	944
Moscow	0	0	0	0	0	0	4	11	1	10	1	10	0	0	6	31
Morton	6	50	3	75	8	50	22	150	6	25	12	100	10	225	67	675
Elkhart	6	50	3	75	8	50	17	130	4	18	11	90	7	200	56	613
Richfield	0	0	0	0	0	0	1	5	1	3	0	0	0	0	2	8
Rolla	0	0	0	0	0	0	4	15	1	4	1	10	3	25	9	54
Haskell	2	100	1	100	7	50	20	150	3	25	11	125	5	200	49	750
Sublette	1	50	0	0	3	15	10	75	2	15	7	80	3	125	26	360
Satanta	1	50	1	100	4	35	10	75	1	10	4	45	2	75	23	290

Footnotes to TABLE A-3

[a]County firm numbers and employment were estimated from information provided by the Kansas Department of Labor and from the census bureau of the U.S. Department of Commerce. A breakdown of firm numbers and employment among the various towns in each county was based on the percentage of total county population in each of the towns.

TABLE A-4

SPECIAL WASTE

County - Town		Construction # Firms	Employment
Garden City Site			
Greeley		1	3
	Tribune	1	3
	Horace	0	0
Wichita		9	50
	Leoti	9	50
Scott		15	125
	Scott City	15	125
Lane		2	50
	Dighton	2	50
Hamilton		0	0
	Syracuse	0	0
	Coolidge	0	0
Kearny		1	4
	Lakin	1	4
	Deerfield	0	0
Finney		74	525
	Garden City	74	525
	Holcomb	0	0
Stanton		2	3
	Johnson	2	3
	Manter	0	0
Grant		22	200
	Ulysses	22	200
Dodge City Site			
Ness		6	25
	Ness City	4	15
	Ransom	1	5
	Bazine	1	5
	Brownell	0	0
	Utica	0	0
Hodgeman		0	0
	Jetmore	0	0
	Hanston	0	0

TABLE A-4 - Continued

County - Town		Construction # Firms	Construction Employment
Gray		7	25
	Cimarron	5	15
	Ingalls	0	0
	Ensign	0	0
	Montezuma	2	10
	Copeland	0	0
Ford		49	425
	Dodge City	45	390
	Spearville	2	17
	Ford	0	0
	Bucklin	2	18
Clark		3	25
	Ashland	2	15
	Minneola	1	10
	Englewood	0	0
Liberal Site			
Meade		4	25
	Meade	3	20
	Fowler	0	0
	Plains	1	5
Seward		35	225
	Liberal	35	225
	Kismet	0	0
Stevens		10	15
	Hugoton	10	15
	Moscow	0	0
Morton		1	1
	Elkhart	1	1
	Richfield	0	0
	Rolla	0	0
Haskell		7	25
	Sublette	7	25
	Satanta	3	10

TABLE A-5

COMMERCIAL AND INSTITUTIONAL WASTE AND SPECIAL WASTE

County - Town	Commercial & Institutional (in tons) Weekly	Annual	Special Waste (in tons) Weekly	Annual	Total Weekly	Annual
Garden City Site						
Greeley	11	591	1	53	12	644
Tribune	9	508	.8	45	10	554
Horace	2	82	.2	8	2	90
Wichita	19	1007	8	393	27	1400
Leoti	19	1007	8	393	27	1400
Scott	32	1658	16	851	48	2509
Scott City	32	1658	16	851	48	2509
Lane	14	731	8	426	22	1157
Dighton	14	731	8	426	22	1157
Hamilton	17	902	1	57	18	959
Syracuse	16	857	1	54	17	911
Coolidge	1	45	0	3	1	48
Kearny	13	720	1	79	14	730
Lakin	11	562	1	56	12	618
Deerfield	2	158	0	16	2	174
Finney	142	7374	84	4366	226	11740
Garden City	137	7153	81	4235	219	11388
Holcomb	4	216	3	136	7	352
Grant	45	2364	35	1796	80	4160
Ulysses	45	2364	35	1796	80	4160
Stanton	9	472	1	48	10	521
Johnson	7	392	.7	40	8	432
Manter	1	80	.3	8	1	88
Dodge City Site						
Ness	16	850	5	267	21	1117
Ness City	10	518	3	163	13	681
Ransom	2	110	.6	35	3	145
Bazine	2	110	.6	35	3	145
Brownell	1	17	.1	5	1	22
Utica	2	93	.5	29	2	123
Hodgeman	11	545	1	51	12	596
Jetmore	8	420	.7	39	9	459

TABLE A-5 - Continued

County - Town	Commercial & Institutional (in tons) Weekly	Annual	Special Waste (in tons) Weekly	Annual	Total Weekly	Annual
Hanston	2	125	.3	12	3	137
Gray	25	1322	4	205	29	1527
Cimarron	12	648	2	100	14	748
Ingalls	2	119	.3	18	3	137
Ensign	2	106	.3	16	2	122
Montezuma	6	317	.9	49	7	366
Copeland	2	132	.2	21	2	153
Clark	15	806	4	207	19	1013
Ashland	9	484	2	124	11	608
Minneola	5	258	15	66	6	324
Englewood	1	65	.5	16	1	81
Ford	198	10281	46	2385	243	12666
Dodge City	180	9355	42	2170	222	11526
Spearville	8	411	2	95	10	507
Ford	2	103	.5	24	2	127
Bucklin	8	411	2	95	10	507
Liberal Site						
Meade	26	1368	6	298	32	1665
Meade	15	779	3	170	18	949
Fowler	4	232	1	51	5	283
Plains	6	356	2	77	8	433
Seward	142	7409	34	1764	176	9173
Liberal	139	7260	33	1729	173	8989
Kismet	3	148	1	35	3	183
Stevens	26	1353	2	102	28	1455
Hugoton	24	1259	.5	95	26	1353
Moscow	2	94	.5	7	2	102
Morton	18	934	2	79	19	1013
Elkhart	15	775	1	66	16	841
Richfield	1	37	.7	3	1	40
Rolla	2	121	.3	10	2	131
Haskell	20	1028	2	98	22	1126
Sublette	11	545	1	52	12	597
Satanta	9	483	1	46	10	529

TABLE A-6

AVERAGE TOTAL WASTE GENERATION (IN TONS)

1975-1995

County - Town	Publically Collected and Disposed		Publically and Privately Collected and Disposed	
	weekly	annual	weekly	annual
Garden City Site	728	37,814	882	45,876
Greeley	24	1247	25	1300
Tribune	21	1062	22	1107
Horace	3	145	3	153
Wichita	46	2397	54	2790
Leoti	46	2397	54	2790
Scott	82	4246	98	5096
Scott City	82	4246	98	5096
Lane	31	1609	39	2035
Dighton	31	1609	39	2035
Hamilton	37	1916	38	1973
Syracuse	35	1815	36	1870
Coolidge	2	101	2	104
Kearny	39	2014	40	2086
Lakin	31	1586	32	1643
Deerfield	8	427	8	443
Finney	349	18,127	432	22,493
Garden City	337	17,545	419	21,780
Holcomb	9	380	12	516
Stanton	25	1294	26	1343
Johnson	21	1093	22	1133
Manter	4	201	4	209
Grant	95	4964	130	6761
Ulysses	95	4964	130	6761

TABLE A-6 - Continued

County - Town	Publically Collected and Disposed weekly	Publically Collected and Disposed annual	Publically and Privately Collected and Disposed weekly	Publically and Privately Collected and Disposed annual
Dodge City Site	563	29,626	622	32,361
Ness	49	2550	54	2817
Ness City	30	1562	33	1725
Ransom	7	351	7	386
Bazine	6	324	7	359
Brownell	1	68	1	73
Utica	5	246	5	275
Hodgeman				
Jetmore	18	946	19	985
Hanston	6	295	6	307
Gray	59	3071	63	3275
Cimarron	31	1596	33	1697
Ingall	5	277	6	296
Ensign	4	225	5	242
Montezuma	13	678	14	728
Copeland	6	293	6	314
Ford	393	20,431	439	22,816
Dodge City	357	18,652	399	20,733
Spearville	17	871	19	966
Ford	5	250	5	274
Bucklin	15	775	17	870
Clark	37	1954	42	2161
Ashland	22	1170	25	1294
Minneola	12	661	14	727
Englewood	2	123	3	139
Liberal Site	528	27,473	572	29,767
Meade	63	3286	69	3584
Meade	37	1898	40	2068
Fowler	10	538	11	589
Plains	16	857	18	934
Seward	303	15,713	336	17,477
Liberal	298	15,477	331	17,206
Kismet	5	276	6	312

TABLE A-6 - Continued

County - Town	Publically Collected and Disposed		Publically and Privately Collected and Disposed	
	weekly	annual	weekly	annual
Stevens	59	3081	61	3183
Hugoton	55	3863	57	2958
Moscow	4	217	4	224
Morton	48	2467	50	2593
Elkhart	41	2110	42	2176
Richfield	1	72	2	75
Rolla	6	332	7	342
Haskell	54	2831	56	2929
Sublette	26	1349	27	1402
Satanta	28	1481	29	1527

TABLE B-1

WEEKLY COLLECTION, TRANSFER, AND DISPOSAL COST

PER ESTABLISHMENT

County - Town		Collection	Transfer	Overhead	Disposal
Garden City Site					
Greeley					
Tribune	HH	.19	.13	.08	.05
	C&I	1.09	.86	.08	.34
Horace	HH	.19	.13	.08	.05
	C&I	1.09	.86	.08	.34
Wichita					
Leoti	HH	.19	.09	.08	.05
	C&I	1.09	.87	.08	.49
Scott					
Scott City	HH	.19	.08	.08	.05
	C&I	1.09	.41	.08	.42
Lane					
Dighton	HH	.19	.08	.08	.05
	C&I	1.09	.64	.08	.42
Hamilton					
Syracuse	HH	.19	.08	.08	.05
	C&I	1.09	.58	.08	.40
Coolidge	HH	.19	.10	.08	.05
	C&I	1.09	.39	.08	.21
Kearny					
Lakin	HH	.19	.04	.08	.05
Deerfield	C&I	1.09	.31	.08	.48
Finney					
Garden City	HH	.19	.01	.08	.05
	C&I	1.09	.05	.08	.58
Holcomb	HH	.19	.01	.08	.05
	C&I	1.09	.06	.08	.31
Grant					
Ulysses	HH	.19	.08	.08	.05
	C&I	1.09	.95	.08	.66
Stanton					
Johnson	HH	.19	.13	.08	.05
	C&I	1.09	1.32	.08	.52
Manter	HH	.19	.15	.08	.05
	C&I	1.09	1.56	.08	.55

TABLE B-1 - Continued

County - Town		Collection	Transfer	Overhead	Disposal
Dodge City Site					
Ness					
Ness City	HH	.19	.09	.10	.07
	C&I	1.08	.36	.10	.30
Ransom	HH	.19	.10	.10	.07
	C&I	1.08	.43	.10	.30
Bazine	HH	.19	.10	.10	.07
	C&I	1.08	.43	.10	.30
Brownell	HH	.19	.12	.10	.07
	C&I	1.08	.62	.10	.32
Utica	HH	.19	.12	.10	.07
	C&I	1.08	.61	.10	.36
Hodgeman					
Jetmore	HH	.19	.05	.10	.07
	C&I	1.08	.34	.10	.54
Hanston	HH	.19	.06	.10	.07
	C&I	1.08	.46	.10	.52
Gray					
Cimarron	HH	.19	.03	.10	.07
	C&I	1.08	.27	.10	.64
Ingalls	HH	.19	.04	.10	.07
	C&I	1.08	.27	.10	.64
Ensign	HH	.19	.02	.10	.07
	C&I	1.08	.20	.10	.64
Montezuma	HH	.19	.10	.10	.07
	C&I	1.08	.37	.10	.64
Copeland	HH	.19	.10	.10	.07
	C&I	1.08	.86	.10	.62
Clark					
Ashland	HH	.19	.18	.10	.07
	C&I	1.08	.49	.10	.46
Minneola	HH	.19	.08	.10	.07
	C&I	1.08	.48	.10	.46
Englewood	HH	.19	.06	.10	.07
	C&I	1.08	.48	.10	.46
Ford					
Dodge City	HH	.19	.01	.10	.07
	C&I	1.08	.06	.10	.84
Spearville	HH	.19	.02	.10	.07
	C&I	1.08	.25	.10	.82
Ford	HH	.19	.03	.10	.07
	C&I	1.08	.29	.10	.78
Bucklin	HH	.19	.04	.10	.07
	C&I	1.08	.47	.10	.82

TABLE B-1 - Continued

County - Town		Collection	Transfer	Overhead	Disposal
Liberal Site					
Meade					
Meade	HH	.19	.06	.10	.07
	C&I	1.08	.51	.10	.64
Fowler	HH	.19	.05	.10	.07
	C&I	1.08	.40	.10	.62
Plains	HH	.19	.04	.10	.07
	C&I	1.08	.35	.10	.64
Seward					
Liberal	HH	.19	.01	.10	.07
	C&I	1.08	.05	.10	.90
Kismet	HH	.19	.03	.10	.07
	C&I	1.08	.24	.10	.66
Stevens					
Hugoton	HH	.19	.05	.10	.07
	C&I	1.08	.42	.10	.64
Moscow	HH	.19	.07	.10	.07
	C&I	1.08	.59	.10	.64
Morton					
Elkhart	HH	.19	.10	.10	.07
	C&I	1.08	.74	.10	.55
Richfield	HH	.19	.10	.10	.07
	C&I	1.08	1.01	.10	.07
Rolla	HH	.19	.08	.10	.07
	C&I	1.08	.52	.10	.53
Haskell					
Sublette	HH	.19	.05	.10	.07
	C&I	1.08	.55	.10	.81
Satanta	HH	.19	.06	.10	.07
	C&I	1.08	.65	.10	.81

TABLE B-2

ESTIMATED MONTHLY COST PER ESTABLISHMENT

County - Town		Collection and Transfer	Disposal	Total Cost Per Month (in $)
Garden City Site				
Greeley				
Tribune	HH	1.60	.21	1.81
	C&I	8.16	1.44	9.60
Horace	HH	1.60	.21	1.81
	C&I	8.12	1.38	9.50
Wichita				
Leoti	HH	1.44	.21	1.65
	C&I	8.16	1.99	10.15
Scott				
Scott City	HH	1.32	.21	1.53
	C&I	6.32	1.57	7.89
Lane				
Dighton	HH	1.40	.21	1.61
	C&I	7.24	1.69	8.93
Hamilton				
Syracuse	HH	1.40	.21	1.61
	C&I	7.00	1.63	8.63
Coolidge	HH	1.48	.21	1.69
	C&I	6.24	.84	7.08
Kearny				
Lakin	HH	1.24	.21	1.45
	C&I	5.92	1.93	7.85
Deerfield	HH	1.16	.21	1.37
	C&I	5.88	1.81	7.68
Finney				
Garden City	HH	1.08	.21	1.29
	C&I	4.80	2.35	7.15
Holcomb	HH	1.08	.21	1.29
	C&I	4.92	1.26	6.18
Grant				
Ulysses	HH	1.40	.21	1.61
	C&I	8.48	2.65	11.13
Stanton				
Johnson	HH	1.60	.21	1.81
	C&I	9.86	2.11	12.07
Manter	HH	1.68	.21	1.89
	C&I	10.92	2.29	13.21

TABLE B-2 - Continued

County - Town		Collection and Transfer	Disposal	Total Cost Per Month (in $)
Dodge City Site				
Ness				
Ness City	HH	1.52	.28	1.80
	C&I	5.04	1.20	6.24
Ransom	HH	1.56	.28	1.84
	C&I	6.44	1.20	7.64
Bazine	HH	1.56	.28	1.84
	C&I	6.44	1.20	7.64
Brownell	HH	1.64	.28	1.92
	C&I	6.80	1.28	8.08
Utica	HH	1.64	.28	1.92
	C&I	7.16	1.44	8.60
Hodgeman				
Jetmore	HH	1.36	.28	1.64
	C&I	6.08	2.16	8.24
Hanston	HH	1.40	.28	1.68
	C&I	6.56	2.08	8.64
Gray				
Cimarron	HH	1.28	.28	1.56
	C&I	5.80	2.56	8.36
Ingalls	HH	1.32	.28	1.60
	C&I	6.24	2.56	8.80
Ensign	HH	1.24	.28	1.52
	C&I	5.52	2.56	8.08
Montezuma	HH	1.32	.28	1.60
	C&I	6.20	2.56	8.76
Copeland	HH	1.56	.28	1.84
	C&I	8.16	2.48	10.64
Clark				
Ashland	HH	1.48	.28	1.76
	C&I	6.68	1.84	8.52
Minneola	HH	1.48	.28	1.76
	C&I	6.64	1.84	8.48
Englewood	HH	1.40	.28	1.68
	C&I	6.32	1.84	8.16
Ford				
Dodge	HH	1.20	.28	1.48
City	C&I	4.96	3.36	8.32
Spearville	HH	1.24	.28	1.52
	C&I	5.72	3.28	9.00
Ford	HH	1.28	.28	1.56
	C&I	5.88	3.12	9.00
Bucklin	HH	1.32	.28	1.60
	C&I	6.60	3.28	9.88

TABLE B-2 - Continued

County - Town		Collection and Transfer	Disposal	Total Cost Per Month (in $)
Liberal Site				
Meade				
Meade	HH	1.40	.30	1.70
	C&I	6.76	2.58	9.34
Fowler	HH	1.36	.30	1.66
	C&I	6.32	2.49	8.81
Plains	HH	1.32	.30	1.62
	C&I	6.12	2.66	8.34
Seward				
Liberal	HH	1.20	.30	1.50
	C&I	4.96	3.61	8.57
Kismet	HH	1.28	.30	1.58
	C&I	5.68	2.66	8.34
Stevens				
Hugoton	HH	1.36	.30	1.60
	C&I	6.40	2.58	8.98
Moscow	HH	1.44	.30	1.74
	C&I	7.08	2.58	9.66
Morton				
Elkhart	HH	1.56	.30	1.86
	C&I	7.68	2.23	9.91
Richfield	HH	1.56	.30	1.86
	C&I	8.76	3.09	11.85
Rolla	HH	1.48	.30	1.78
	C&I	6.80	2.15	8.95
Haskell				
Sublette	HH	1.36	.30	1.66
	C&I	6.92	3.44	12.02
Satanta	HH	1.40	.30	1.70
	C&I	7.32	3.44	10.76

TABLE C-1

DEFINITION OF TERMS

Aricultural Waste - Solid Waste resulting from the production of farm or agricultural products such as manures, crop residues, etc.

Air Pollution - The presence in the outdoor atmosphere of one or more air contaminants in such quantity and duration as is or tends significantly to be injurious to human health or welfare, animal or plant life, or property, or would unreasonably interfere with the enjoyment of life or property.

Ashes - Residue from incineration, i.e., cinders.

Bulky Waste - Large items of refuse such as appliances, furniture, large vehicle parts, trees and branches, stumps, and similar large items not easily crushed or reduced in volume using light landfilling equipment.

Commercial Wastes - Wastes from wholesale, retail or service establishments, including restaurants, hotels, shopping centers, office buildings and warehouses. Also included are restaurant or cafeteria wastes from industrial establishments.

Compost Plant - An installation utilizing a process based upon the biodegradation of organic materials to a sanitary, nuisance-free, humus-like product, to which the major raw material input consists of garbage and/or total refuse disposal.

Composting - A process for biological decomposition of organic waste in a nuisance-free manner through controlled environment, either aerobic or anaerobic, producing a stable residue which may be used as a soil conditioner.

Construction and Demolition Wastes - Waste building materials and ruble resulting from construction, remodeling, repair, and demolition operations on houses, commercial buildings, pavements and other structures, including: lumber, roofing, sheathing, plastic, conduit, pipe, wire, and insulation scraps and rubble and broken concrete, etc.

Garbage - Garbage is the solid or semi-solid animal and vegetable waste resulting from the handling, preparation, cooking and serving of foods, including cans, bottles and cartons in which it was received and wrappings in which it may be placed for disposal. Garbage does not include commercial and industrial waste from meat-packing plants, food processing plants such as canneries and crop waste from farms, nor market wastes which originate in wholesale and retail stores or markets engaged in the storage, processing and selling of food products.

TABLE C-1 - Continued

Groundwater - Water in the ground that is in the zone of saturation.

Hazardous Waste - Solid and liquid waste which requires special handling and disposal to protect and conserve the environment and shall include pesticides, acids, caustic, pathological waste, radioactive materials, flammable or explosive materials, oils and solvents and similar chemicals and materials, and shall include containers and materials that have been contaminated with hazardous wastes.

Incineration - The controlled process of burning solid, semi-solid, liquid or gaseous combustible wastes in an enclosed device, producing an inoffensive gas and a sterile residue containing little or no combustible material. The processes used to reduce the volume or weight of waste material or to change the characteristics of hazardous wastes to a safer form.

Incinerator Residue - Ashes, metals, glass, ceramics, etc., resulting from reufse incineration.

Industrial Waste - Solid wastes resulting from industrial processes and manufacturing operations which are not suitable for discharge to a sanitary sewer or treatment in a sewage treatment plant such as : food-processing waste, wood, plastics, metal scrap, etc.

Institutional Wastes - Refuse from schools, hospitals, research institutions, non-profit organizations and public buildings.

Nuisance - Anything which is injurious to health, or is offensive to the senses or any obstruction to the free use of property so as to interfere with the comfortable enjoyment of life or property, or adversely affects an entire community or neighborhood, or any substantial number of persons even though the extent of the annoyance or damage inflicted upon individuals may be unequal, and is caused by or is a result of the handling or disposal of solid wastes.

Pollution - The contamination of any air, water or land so as to create a nuisance or render such air, water or land unclean or noxious, or impure so as to be actually or potentially harmful or detrimental or injurious to public health, safety, or welfare, to domestic, commercial, industrial or recreational use, or to livestock wild animals, birds, fish, or other aquatic life or to plant life.

Refuse - Unwanted or discarded material resulting from household, commercial, industrial, and agricultural operations and from normal community activities. Refuse includes in part the following: garbage; rubbish, ashes and other residue after burning; street refuse; dead animals; animal waste; motor vehicles; agricultural, commercial, and industrial waste; construction and demolition waste, and sewage treatment residue; provided, however, that the term "refuse" does not include any uncontaminated earth, stone, or minerals.

TABLE C-1 - Continued

Salvaging - The controlled removal of reusable materials, not to be confused with scavenging.

Sanitary Landfill Operation - A method of disposing of solid wastes on land without creating nuisances or hazards to the public health or safety by confining refuse to the smallest practical area, compacting it to the smallest practical volume by employing power equipment, and covering with a layer of compacted earth or other suitable cover material at the conclusion of each day's operation.

Solid Waste Management System - The entire process of storage, collection, transportation, processing and disposal of solid wastes by any city, authority, county or any combination thereof, or by any person engaging in such process as a business.

Solid Waste - Garbage, refuse, and other discarded material including, but not limited to, solid and liquid waste materials resulting from domestic, industrial, commercial, agricultural, and community activities.

Vector (of disease) - An animal or insect which transmits infectious diseases from one person or animal to another by biting the skin or mucous membrane or by depositing infectious material on the skin, on food, or on another object.

Yard Rubbish - Prunings, grass clippings, weeds, leaves, and general yard and garden wastes.

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AN ANALYSIS OF THE COSTS OF PROVIDING SOLID WASTE DISPOSAL SERVICES IN SOUTHWEST KANSAS: A MULTI-COUNTY PLAN

by

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The increasing cost of providing public services is a problem at all levels of government. They are faced with handling increasing cost problems while maintaining quality service within their respective jurisdictions. These two problems intensify in a region with a sparse population and a relatively large geographical area. Recently, there has been an interest in several government units jointly offering various public services with the intention of providing a more economical and efficient service. One such approach is the multi-county effort.

This study dealt with a multi-county plan for solid waste disposal services in a large and sparsely populated area. In the study, per unit costs were determined for such a plan. The nineteen county Greater Southwest Kansas Region was used in this study. Solid waste generation was projected for a twenty year period from 1975-1995. Industrial and commercial feedlot establishments were excluded from the study since the waste materials generated by these firms is best handled and disposed of by the respective firms. Rural and unincorporated areas were also excluded since, due to the few establishments in such a region, they are not required to participate in such a program.

The primary factors influencing solid waste generation are population, personal income, the level of economic activity within the region, and technological changes in relation to disposable containers. Based upon recent regional projections, the population in the region was estimated to remain near its present level for the next twenty to thirty years and may in fact decline.. Most of the loss in population will come from the rural and unincorporated areas and from towns with less than fifteen hundred persons. Per capita waste generation however, due to an increased standard of living and technological changes, is expected to increase at a rate of from one to two per cent annually.

Sanitary landfilling, according to recent studies was determined to be the most economical method of solid waste disposal for such a region. This process is suitable for areas where land is relatively abundant and available.

In the study the total cost of providing solid waste disposal services was found. Determining an equal trade-off point between transfer costs and disposal costs was necessary in order to minimize total costs. While economies of scale are present in disposal operations, longer hauls are needed in order to provide the additional volume required to reduce the costs of disposal operations. In doing so, transfer costs are increased. By use of the Stollsteimer Model for Plant Numbers and Locations, an equal trade-off point between transfer and disposal operations was found.

Costs were determined for each establishment on the basis of time needed to complete the collection, the weight of the material collected, the round-trip distance from the respective town to the disposal area, and the cost of disposing the material at the site. Monthly user fees were estimated for each household and commercial and institutional establishment within the region.

The results of the study indicated that a multi-county unit may be more economical than a series of single county units. If quality of service provided is maintained, multi-county solid waste disposal units should be considered as an alternative to single county units.