solid waste handling and disposal in multistory buildings and hospitals

VOLUME I

summary, conclusions, and recommendations

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This final report (SW-34d.1) on work performed under solid waste management demonstration grant no. EC-00164 to the County of Los Angeles was written by ESCO/GREENLEAF *and is reproduced as received from the grantee.*

VOLUMES II AND IV *Observations of Local Practices* (SW-34d.2) and *Selection and Design of Solid Waste Systems* (SW-34d.4) are available from the Department of Commerce, National Technical Information Service, Springfield, Virginia.

VOLUME III *Research on Systems Development* (SW-34d.3) is available under separate cover from the U.S. Government Printing Office, Washington, D.C.

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FOREWORD

In the past century of national growth, reflected in increased population, expanding municipalities, and greater industrial and commercial enterprises, this Nation responded with nonconcern to a concurrent physical deterioration of the country. The first comprehensive water pollution control legislation was not enacted until 1956; the first comprehensive air pollution legislation, in 1963: Finally, six years ago, legislation acknowledged a national solid waste problem--a pollution that can pervade the air, water, and land.

Under the Solid Waste Disposal Act of 1965 (Title II, P. L. 89-272) and now under the broader mandate of the Resource Recovery Act of 1970 (P. L. 91-512), municipalities and other agencies are eligible to apply for Federal demonstration grants to study, test, and demonstrate techniques which advance the state of the art in the solid waste management field.

Disquieting statistics compiled by the U.S. Environmental Protection Agency point up the significance of these solid waste management demonstration projects. The Nation's outlay for getting rid of its debris is $4.5 billion annually--and growing. Most of this cost is: (1) for collecting only part (180 million tons) of the 360 million tons of household, commercial, and industrial waste actually being generated; (2) for disposing of it in dumps or landfills (94 percent of which are unsatisfactory) or in incinerators (75 percent of which are inadequate). One basic Federal policy has been to encourage the concept of areawide solid waste management as a sound vehicle for raising the overall level of these sanitation services to safeguard environment and public comfort.

The County of Los Angeles received one of these demonstration grants, to make an in-depth study of solid waste handling and disposal in multistory buildings and hospitals. The results are reported herein.*

--SAMUEL HALE, JR.
Deputy Assistant Administrator
for Solid Waste Management

*For studies also related to collection and disposal of solid wastes in high-rise buildings, refer to National Academy of Sciences--National Research Council. Collection, reduction, and disposal of solid waste in high-rise multifamily dwellings. Rockville, Md., U.S. Environmental Protection Agency, 1971. [Distributed by National Technical Information Service, Springfield, Va., as PB 198 623. 169p.]

ACKNOWLEDGMENT

The ultimate purpose of this study is to determine improved solid waste handling and disposal techniques adaptable to various types of multistory buildings, hospitals and detention facilities. This research initiated by the Project Planning and Pollution Control Division, Department of County Engineer, County of Los Angeles, was performed with the assistance of the Solid Wastes Program, National Center for Urban and Industrial Health, U.S. Public Health Service, Department of Health, Education and Welfare,* and through guidance of the Advisory Committee on Solid Wastes, organized by the Department of County Engineer to assist the project team throughout the study period.

ESCO-GREENLEAF, A Joint Venture (Engineering Service Corporation, Los Angeles, California, and Greenleaf/Telesca, Engineers & Architects, Miami, Florida) was selected by the Board of Supervisors to conduct this study in collaboration with the Project Planning and Pollution Control Division. Special consultants assisting the project staff in certain aspects of the study include Elmer R. Kaiser, Senior Research Scientist, New York University; George S. Michaelsen, Professor and Director, Division of Environmental Health and Safety, University of Minnesota; Richard G. Bond, Professor, School of Public Health, University of Minnesota; Donald Vesley, Assistant Professor, School of Public Health, University of Minnesota; and Gordon P. Larson, Air Pollution Control Consultant, Philadelphia, Pennsylvania.

Considerable interest in this study has been shown by many governmental agencies, equipment manufacturers and individuals directly concerned with the subject. With this encouragement, together with the direct and indirect assistance of numerous contributors, enthusiasm for successful completion of the study has been maintained.

Sincere appreciation is extended to the administrators and staffs of all hospitals, members of the Sheriff's Department and representatives of the Department of Building Services, who cooperated and assisted in the on-site investigations in those buildings under their respective jurisdictions.

The constructive criticism and guidance of members of the Advisory Committee on Solid Wastes were invaluable and special recognition for the member agencies is warranted. Agencies represented in this Committee include: Los Angeles County, Hospital Department, Mechanical Department, Building Services, Health Department, Forester and Fire Warden, Department of County Engineer, and Air Pollution Control District; and the State of California, Department of Public Health and Regional Water Quality Control Board.

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* Now the Office of Solid Waste Management Programs, U.S. Environmental Protection Agency.

PREFACE

Problems of solid waste collection and disposal in institutions and other multistory buildings mirror many of the same problems confronting the community at large--in greatly magnified form. In large building complexes, as in many of the Nation's communities, solid waste systems often are so crude as to be termed, in the words of this report, "man-handling." Either in large buildings, the subject here, or in a community, a two-prong approach will be necessary--immediate application of improved methods that are presently available, and then planning and research for optimal future solutions.

This study, supported in part by solid waste management demonstration grant no. G06-EC-00164 from the Environmental Protection Agency, reflects this approach, and hopefully will motivate administrators and designers concerned with multistory complexes to consider solid waste handling and disposal as an integral factor in the total service system provided for these buildings. Such a consideration must take into account safety, sanitation, convenience, and cost. The complete study is reported in four volumes:

Volume I, Summary, Conclusions, and Recommendations, presents a digest of study objectives, development of systems evaluation methodology, and criteria for systems design, together with a brief review of the total study. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

Volume II, Observations of Local Practices, is a detailed study and evaluation of systems and practices in fifteen County-owned building complexes, including seven hospitals, four multistory office buildings, and four detention facilities, varying in function and size within each classification. This report establishes the theoretical standards of operation peculiar to each plant and, through field observations, actual operating conditions of these systems. Available from the U.S. Department of Commerce, National Technical Information Service, Springfield, Virginia 22151.

Volume III, Research on Systems Development, covers an investigation and evaluation of available solid waste handling, storage, processing, and disposal equipment and systems adaptable to building installations. This report provides coverage on both marketed systems and equipment components, as well as systems concepts in the development and "idea" stage. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

Volume IV, Selection and Design of Solid Waste Systems, provides an extended evaluation of systems adaptable to the various classifications of buildings and complexes considered in the study, with recommendations for operational improvements or modifications of existing systems as may be required in each type of facility. Design criteria and preliminary design of systems modifications, together with outline specifications and cost estimates covering installation and operation, are developed on a selected building complex. Available from the U.S. Department of Commerce, National Technical Information Service, Springfield, Virginia 22151.

John A. Lambie, County Engineer, County of Los Angeles, was the project director for this study; Peter M. McGarry, with our Division of Demonstration Operations, was the project officer.

--JOHN T. TALTY, *Director*
Division of Demonstration Operations
Office of Solid Waste Management Programs

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APPENDICES

The need for this study was motivated by observed lack of progress, both locally and nationally, in development and use of improved systems and equipment for handling and disposal of solid wastes in multistory buildings.

Since 1920, when the solid waste production per capita was 2.7 lbs. per day, there has been a steady increase in the rate of production of solid waste. In recent years, the increase has been at an even more rapid rate as copying machines and disposable items have come into more general use, and it is now reported that the waste production is in excess of 5 lbs. per capita per day. Although wages have increased manyfold during the same period, mechanization and automation - in most fields - have kept costs under reasonable control. The gathering of solid waste inside of buildings, especially multistory buildings and multi-building complexes, has shown little change during this period and manpower is still relied upon for picking up and transporting refuse within buildings to central points of collection or disposal.

Newly constructed buildings are in most cases still utilizing solid waste handling systems which were conceived and developed many years ago, and it is not unusual to find a row of waste cans lined up in front of a multi-million dollar monumental building waiting for collection. In multistory buildings, trash is often manhandled at great expense. Occupants of apartment buildings complain of noise and odors from filthy trash chutes, and there is a constant fire hazard in the storage rooms. New rubbish handling systems can and must be developed and their use must be required.

Although phenomenal progress has been made in the field of medicine and new methods and equipment are being developed for the care of hospital patients, very little progress has been made in changing methods of disposing of solid waste from these institutions. The health hazards resulting from present outdated systems are a real concern to health authorities and sanitary engineers. There is a need for research and development in this area which so closely affects our environment.

The need for an integrated system for solid waste disposal in hospitals is obvious. Present archaic systems require considerable handling which is not only becoming increasingly expensive, but results in frequent exposure to disease and filth. Wastes are often transported through corridors of hospitals and up and down elevators, thus exposing countless patients, staff and visitors to potential accident and infection hazards.

The volume of hospital solid wastes being produced is constantly on the increase. One reason for this is the use of disposables. Because the present philosophy suggests it is "cheaper, faster, safer" to use it once and throw it away, total expenditures for disposables are increasing at an accelerating rate of growth. This trend will greatly increase the volumes of solid waste and increase the magnitude of the entire (logistics) problem.

In hospitals, methods need to be devised for conveying wastes from their source to a storage area or ultimate disposal, ideally with the least handling and exposure to the occupants of the building and community. Consideration should be given to the possibility of combined handling systems to include transportation of supplies and linens throughout the hospital. Provisions for cleaning and maintenance of the materials handling system must be considered during the design and selection phase. Strong emphasis should be given to studying what can be done in older facilities to minimize present problems.

Various methods of reducing the volume of solid waste stored in buildings need to be studied. The feasibility of compressing, shredding, and packaging refuse within the building should be explored. Most refuse could easily be crushed and compacted to a fraction of its original volume with the use of a satisfactory crushing or grinding mechanism.

Even though refuse storage is generally an indispensable function of a building, it is seldom given adequate consideration by builders and designers. Refuse storage continues to be a source of problems for fire and health officials. The ultimate methods of disposal in a building must be coordinated with the planning of the site as well as the design of the waste handling system. The present requirements for in-building storage may be minimized with a system employing conveyor systems that continuously transport wastes to a central storage or processing station.

Present day planners, architects and engineers appear to have no faith in the newer sophisticated waste handling systems. There is a need for evaluating this new equipment under operating conditions so that real progress can be made.

Purpose of the Study:

The purpose of this study is (1) to determine the current "state-of-the-art" in refuse handling and disposal systems serving various types of multistory buildings and building complexes, (2) to determine prevailing methods, practices and equipment employed in waste systems, as well as the standards of operation, (3) to identify specific areas of weakness in waste systems operation, and (4) to identify available equipment or equipment in the development stage that may be used to improve handling, storage, processing and/or disposal methods.

Study Objectives:

The objectives of this total project are to improve solid waste handling and disposal in multistory office buildings, hospitals and detention facilities. This project will be undertaken in two phases. The broad objectives under Phase I as undertaken in this study are (1) to evaluate and determine the types and quantities of solid waste produced by multistory office buildings, hospitals, and detention facilities, and to predict future quantities, (2) to study and evaluate materials handling and waste disposal equipment and systems, (3) to study the application of such handling and disposal equipment or systems to the buildings under consideration, and to review existing County-owned facilities and recommend changes in refuse handling systems, and (4) recommend projects to be constructed so as to demonstrate their effectiveness in a selected multistory hospital, office building or detention facility and develop positive data on the protection of public health, operating efficiency, reliability, and cost.

Under Phase II, a proposed continuation of this study, objectives will include: (1) the design and construction of a selected waste handling and disposal system, (2) the testing and evaluation of the system's performance; and (3) the development of code requirements and guidelines for architects, engineers, planners, and builders for providing acceptable and convenient waste storage, handling, and/or disposal for hospitals, institutions, multistory buildings, including offices and apartments.

Broad descriptions of work tasks that would lead to these objectives were outlined prior to commencing the study. The basic tasks were expected to include:

1. Field surveys of selected local buildings or institutions to determine physical characteristics and obtain data on the refuse collection and disposal system.

2. Analysis and evaluation of the present refuse collection and disposal system for each building or institution from economic, esthetic, and sanitary viewpoints.

3. Research and investigation of refuse collection; preparation and handling systems to determine operating characteristics, size and space requirements, and cost of installation and operation.

4. Research and investigate the various methods of refuse disposal, including salvage, waterborne disposal in sewers after grinding, landfill, composting, on-site and central incineration, taking into account health hazards, air pollution, reliability, and operating cost.

5. Studies to determine which type or types of refuse collection, preparation and handling systems can best be employed in each of the types of buildings under consideration, and the benefits that would result from such an installation. Consideration to be given to shredding, pulping and compacting of refuse and to gravity, pneumatic, vacuum and containerized handling systems and other methods.

6. Coordinate research and investigations with study of grinders for disposal of hospital wastes currently being undertaken by County Health Department.

7. Studies to determine which method or methods of refuse disposal can best be employed in each of the types of buildings or building groups under consideration.

8. Selection of a multistory office or detention facility building to be used as the basis of a demonstration project and prepare preliminary designs and estimates of cost for installing the refuse collection, preparation, handling, storage and/or disposal equipment, including modifications required in the buildings, if any.

9. Selection of a hospital building complex to be used as a demonstration project for a system of collection and disposal for hospital wastes and the development of preliminary designs and estimates of cost for the construction and operation of such system.

Further, the objectives of this study of local interest will include an in-depth survey of the refuse collection and disposal facilities and practices at various County buildings and institutions for the purpose of improving and modernizing equipment, methods and practices, and at the same time suggest design standards and code requirements that may insure adequate solid waste system capabilities in future buildings to be constructed within the County jurisdiction. The following list of County buildings or institutions with their varied use and relative size, provides a broad base upon which to conduct this study. The study will also include inspection of such representative private multistory buildings as may be needed to verify and confirm the data based on the study of the County buildings.

Name	Use	Reported Size
LAC-USC Medical Center	Hospital	3,000 beds
Long Beach General Hospital	Hospital	428 beds
Harbor General Hospital	Hospital	715 beds
Rancho Los Amigos Hospital	Hospital	1,188 beds
John Wesley Hospital	Hospital	259 beds
Olive View Hospital	Hospital	725 beds
Mira Loma Hospital	Hospital	232 beds
Mira Loma Sheriff's Facility	Detention Facility	500 inmates
Central Jail	Detention Facility	3,000 inmates
Sybil Brand Institute	Detention Facility	600 inmates
San Fernando Juvenile Hall	Detention Facility	411 inmates
Hall of Justice	Detention Facility	3,000 inmates
Hall of Records	Office Building	404,000 sq. ft.
Hall of Administration	Office Building	1,000,000 sq. ft.
County Courthouse	Office Building	660,000 sq. ft.
County Engineer Building	Office Building	171,000 sq. ft.

Organization of Material:

As this study progressed and expanded to a multi-volume presentation providing a breakdown in the major divisions of the investigation, it became apparent that the voluminous material must be condensed to summary form for interest, continuity and value. Hopefully, one of the principal values will be the emphasis to the readers of the relatively little previous input to this subject of solid waste systems in buildings and the need for continuing study.

Contents of this volume include background material that was necessary to develop prior to proceeding with field investigation and analysis of solid waste systems. This background material, incorporated in Chapters II and III, identifies functions and nomenclature of solid waste systems in building complexes for purposes of this study and establishes a numerical rating basis for the evaluation of waste systems. This rating basis is confined to performance capabilities of the systems as related to effect on the environment, both in-plant and off-site.

Chapters IV and VI, covering investigations on existing systems in selected local buildings and upgrading of these systems, applies the principles of evaluation developed for this study and explores the economic aspects of solid waste system operation. These chapters summarize the detailed studies to be found in Volumes II and IV, and includes selected appendages from these volumes to illustrate the depth of study.

Chapter V summarizes the scope of activity involved in the research and investigation of equipment and systems as presented in Volume III. The reader is referred to this volume for specific information on equipment components.

Chapter VII presents recommendations for the continuation of this study and the proposed design of a solid waste system for a major building complex. Recommendations are also made on additional areas of study that should be explored to broaden knowledge on solid waste systems in buildings and the effect on the community.

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At the outset of this study, it was indicated that existing descriptive terminology for solid waste systems in buildings was not wholly adequate. Definitions of functions related to handling and disposal of wastes in buildings were not specific. Standardization of nomenclature of solid waste systems had not been fully established. Definitions of solid waste materials and the nature and character of these materials as related to the wastes generated in specific buildings had not been fully developed. Therefore, for clarity and understanding, review and selection of terminology were undertaken as the first steps in this study.

Functions of a Solid Waste System:

The connotation of "system" within this report denotes a building utility requirement, such as a plumbing system. For purposes of this study, the four principal functions of a solid waste system are limited to waste handling, storage, processing and disposal.

The term "waste handling" includes all those functions associated with the transfer or movement of solid waste materials after creation, excluding storage and actual processing and/or ultimate disposal methods that may be employed. These waste handling functions are limited to and defined as follows:

collection - Methods and equipment used in (1) the pickup of accumulated wastes from the initial point of deposit or subsequent storage points and (2) loading of vehicles or other means of conveyance for transport.

transport - Methods and equipment used in the vertical or horizontal movement of materials.

discharge - Methods and equipment used to unload wastes from the carrier or transporter.

Storage of wastes is the interim containment of accumulated materials in either loose, compacted or other processed form prior to subsequent handling, processing or disposal.

Waste processing is considered as those preparation functions, such as bagging or encapsulating of disposables and reusables as well as treatments of disposables involving volume reduction through changes in size and shape, uniformity or consistency. The degree of volume reduction and corresponding increase in density varies with the method or combination of methods employed and the composition of the material input. Typical processes or combinations of these processes which precede ultimate disposal may include:

Bagging	Shredding	Pulverizing
Encapsulating	Chipping	Dewatering
Compaction	Grinding	Baling
Crushing	Pulping	Extrusion

Waste processing may also include those techniques employed in reconditioning or reprocessing reusable equipment such as laundry, bottle washing, dishwashing, washing and rinsing, sterilization and autoclaving. However, the scope of this study shall be limited to the handling methods associated with reusables up to the point of reprocessing.

Disposal is considered herein as the final treatment or combination of treatments in the conversion of wastes to innocuous materials or useable by-products. By and large, known disposal methods are limited to relatively few conversion processes, some involving conversion by normal decomposition of materials and several processes which involve accelerated conversion.

Conversion of waste may be accelerated by destructive disposal processes such as controlled incineration and supervised or unsupervised open burning. Conversion may also be accomplished by natural composting or accelerated by means of various mechanized systems. Grinding of domestic and commercial food wastes for discharge to sewers with ultimate processing at treatment plants and final disposal of sludge at sanitary landfills or other disposition is popularly accepted in many areas as the best disposal method for garbage. In addition, other terminal processes such as wet air oxidation and pyrolysis are among the newer accelerated conversion processes being explored. Reclamation of selected waste materials (paper, rags, metals, glass etc.), rendering of animal carcasses and fats for production of glues, fertilizers and soaps, as well as salvage of food wastes for swine feeding, are representative of the accelerated conversion processes by salvage. Disposal by sanitary landfill, open dumping, dumping at sea and natural composting are the only processes where conversion is not normally accelerated by man, where normal bacteriological decomposition of material occurs.

Nomenclature of the Solid Waste System:

Preliminary investigations revealed that popularly accepted terminology for descriptions of solid waste systems in buildings appeared to be generally non-existent. The need for identification of the system's basic components and working parts or functions of these components appeared to be a prerequisite to detailed investigation and analysis of actual working systems. For this identification, the requirements of the solid waste system (handling, storage, processing and disposal) serving a complex of multistory buildings were considered. It was indicated that the flow of wastes from creation to ultimate disposal would present the full range of system functions that could normally be expected in any major building complex. This hypothetical waste system was resolved into four basic components or sub-systems:

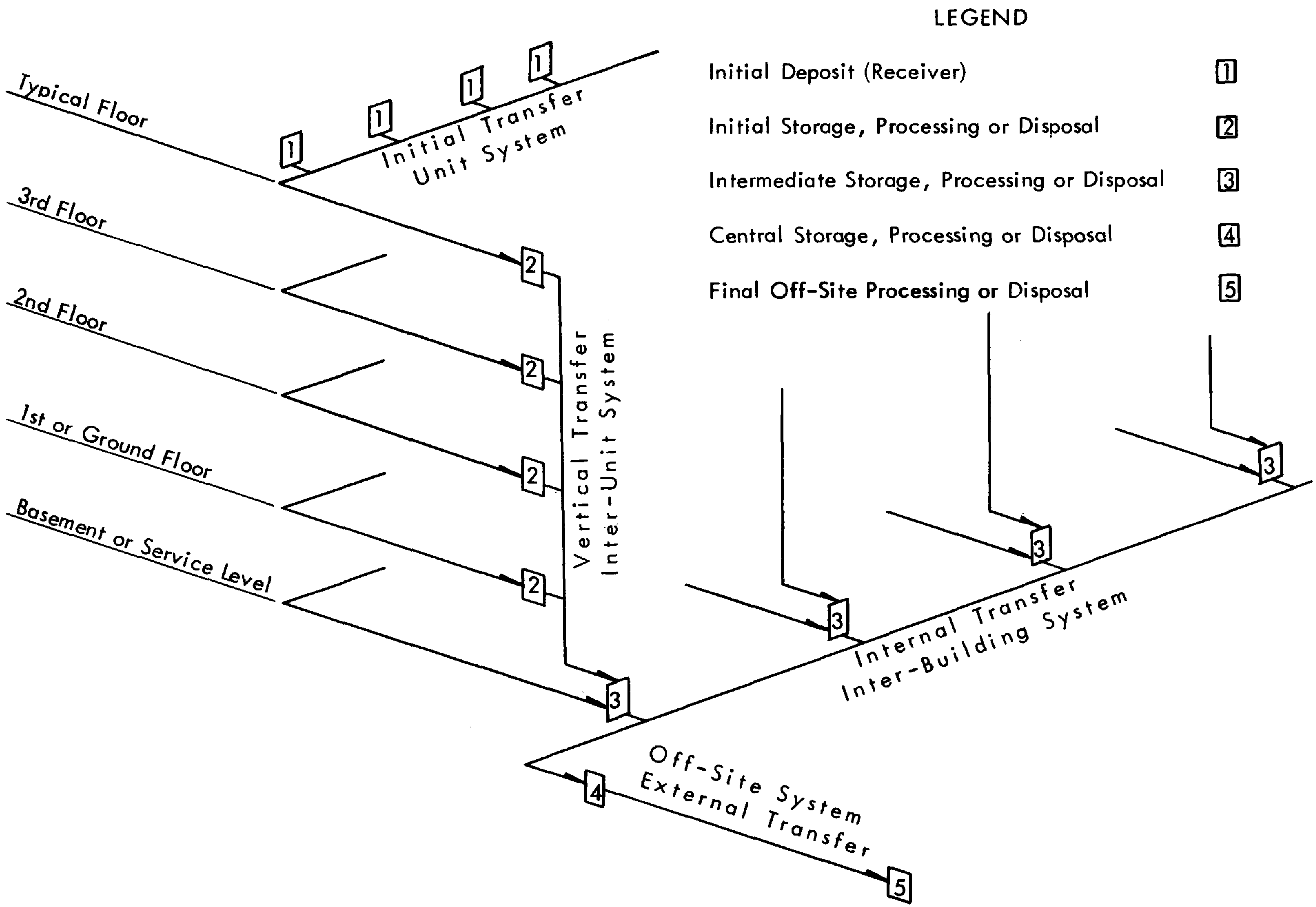
1. The unit system - those initial functions performed in containing and moving waste from its point of creation to and including the point of storage, processing or disposal within the unit. A unit may be defined as a single floor or limited area or zone of a floor.

2. The inter-unit system - those functions performed in the vertical or horizontal transfer of wastes from two or more unit (floor or departmental) storage areas to and including an intermediate storage, processing or disposal point serving a group of units.

3. The inter-building system - those functions performed in the transfer of wastes from intermediate storage points to and including a central on-site storage, processing or disposal point.

4. The off-site system - those functions performed in external transfer of wastes from the central storage area to and including off-site processing or disposal.

Figure II-1, a schematic diagram, illustrates the typical multistory system, identifying components and functions within the system.



SCHEMATIC OF TYPICAL SOLID WASTE SYSTEM IN A MULTISTORY BUILDING COMPLEX FIGURE II-1

Definitions of Solid Waste Materials:

The comprehensive terminology and definitions as employed by *APWA in their publication "Municipal Refuse Disposal" describing wastes and the nature and character of refuse materials have been adopted for use in this study, with certain supplementary modifications as may be pertinent to descriptions of wastes generated in building types studied herein.

APWA terminology and definitions are as follows:

1. Waste refers to the useless, unwanted, or discarded materials resulting from normal community activities, including solids, liquids, and gases.

2. Atmospheric wastes consist of particulate matter, such as dust and smoke, fumes, and gases.

3. Liquid wastes consist mainly of sewage and industrial wastewaters, including both dissolved and suspended matter.

4. Solid wastes are classed as refuse.

5. The physical state of wastes may change in their conveyance or treatment. Dewatered sludge from wastewater treatment plants may become solid wastes; garbage may be ground and discharged into sewers becoming waterborne wastes; and fly ash may be removed from stack discharges and disposed of as solid or as waterborne wastes.

6. Refuse comprises all of the solid wastes of the community, including semi-liquid or wet wastes with insufficient moisture and other liquid contents to be free-flowing.

7. The component materials of refuse can be classified by (a) point of origin, (b) the nature of the material itself, and (c) character of materials.

8. Special wastes are defined as (a) hazardous wastes by reason of their pathological, explosive, radioactive, or toxic nature, and (b) security wastes: confidential documents, negotiable papers, etc.

*American Public Works Administration

Table II-1 presents the APWA classification of refuse materials defining the character, nature and kinds of typical materials as well as their conventional point of origin. Nearly all these kinds of refuse materials are produced in major building complexes. However, for purposes of this study, identification of solid waste materials generated in special purpose buildings must be further detailed. The point of origin or source may be further refined indicating building, floor and/or department where wastes are generated. Supplementing the APWA classifications of waste materials in connection with hospitals, the character of solid waste must be further expanded to include certain reusable wastes.

Kinds of these materials are soiled linens, instruments, accessories, bottles, food utensils,etc. The importance of classifying these materials as solid waste cannot be overemphasized for they are presently handled in a manner similar to disposable waste materials, they exist in quantities that generally exceed the quantities of disposable materials and with the growing popularity of single use items, they may be in fact converted to disposable materials on relatively short notice.

Further classification of the nature of hospital waste must also include definitions of contaminated and non-contaminated materials. It can be assumed that a textbook definition of contaminated and non-contaminated waste materials would produce a clear distinction between these material classifications. However, in practice, due to the complexities of the waste handling systems and the prevailing intermix of "clean" and "dirty" areas generating wastes, segregation of waste materials throughout the system must rely heavily on the human element of judgment in the classification and distinction of these types of materials. Observations further supported by opinions of hospital and health department representatives indicate that reliability in this method of segregation cannot practically nor economically be achieved. Therefore, the following definitions of contaminated and non-contaminated wastes based on point of origin are adopted for purposes of this study.

Those solid waste materials resulting from non-medical activities not directly or physically related to patient care, such as materials generated through warehousing, processing and preparation of new or sterile materials and supplies, will be considered as non-contaminated wastes, providing physical barriers reasonably isolate these service areas and the wastes are not later intermingled.

TABLE II-1 CLASSIFICATION OF REFUSE MATERIALS

Kind or Character	Composition or Nature		Origin or Source
Garbage	Wastes from the preparation, cooking, and serving of food. Market refuse, waste from the handling, storage, and sale of produce and meats		From: households, institutions, and commercial concerns such as: hotels, stores, restaurants, markets, etc.
Rubbish or Mixed Refuse	Combustible (primarily organic)	Paper, cardboard, cartons Wood, boxes, excelsior Plastics Rags, cloth, bedding Leather, rubber Grass, leaves, yard trimmings	
	Noncombustible (primarily inorganic)	Metals, tin cans, metal foils Dirt Stones, bricks, ceramics, crockery Glass, bottles Other mineral refuse	
Ashes	Residue from fires used for cooking, heating buildings, incinerators, etc.		
Bulky Wastes	Large auto parts, tires Stoves, refrigerators, other large appliances Furniture, large crates Trees, branches, palm fronds, stumps, flotage		From: streets, sidewalks, alleys, vacant lots, etc.
Street refuse	Street sweepings, dirt Leaves Catch basin dirt Contents of litter receptacles		
Dead animals	Small animals: cats, dogs, poultry, etc. Large animals: horses, cows, etc.		
Abandoned vehicles	Automobiles, trucks		
Construction & Demolition wastes	Lumber, roofing, and sheathing scraps Rubble, broken concrete, plaster, etc. Conduit, pipe, wire, insulation, etc.		
Industrial refuse	Solid wastes resulting from industrial processes and manufacturing operations, such as: food-processing wastes, boiler house cinders, wood, plastic, and metal scraps and shavings, etc.		From: factories, power plants, etc.
Special wastes	Hazardous wastes: pathological wastes, explosives, radioactive materials Security wastes: confidential documents, negotiable papers, etc.		Households, hospitals, institutions, stores, industry, etc.
Animal and Agricultural wastes	Manures, crop residues		Farms, feed lots
Sewage treatment residues	Coarse screenings, grit, septic tank sludge, dewatered sludge		Sewage treatment plants, septic tanks

SOURCE: APWA REFUSE COLLECTION PRACTICES

All solid wastes generated from the use of clean materials and used in connection with patient care through clinical services, medical support services and certain non-medical services (including food service, soiled linens etc.) will be considered as contaminated wastes. Biological and infectious wastes generated as a result of patient treatment, operating and autopsy procedures, and laboratory research activities will, of course, also fall within this classification as will hazardous wastes such as radioactive, explosive and toxic materials.

Basically, these definitions limit non-contaminated wastes to those materials such as packaging and containerizing of new materials, wastes resulting from food preparation, and processing of other clean products, as well as those waste materials generated by administrative departments and other similar functions not physically related to patient care and easily affording controlled segregation of waste materials from point of origin to point of disposal without intermixing with contaminated wastes.

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Evaluation of solid waste systems may be defined for purposes of this study as the determination of the efficiency of equipment and methods employed in the total system to perform the functions of handling, storage, processing and disposal of wastes in compliance with the requirements of existing codes and accepted standards.

This evaluation must be resolved into two components. These components are performance capabilities of the systems or equipment as designed (theory) and as operated (practice). The latter introduces the human element of operating personnel.

Applicable regulatory controls pertaining to operation and maintenance of solid waste systems include building, fire, pollution and health standards and other local restrictive ordinances, as well as departmental or in-plant regulations and certain special controls such as the Hospital Licensing Act applicable in California.

These codes and standards applicable to handling, processing and disposal of solid wastes for building installations can be resolved to controls for four basic environmental factors or conditions affecting the health and welfare of the general public and building occupants. These four highly interrelated factors are sanitation, safety, security and esthetics and may be defined as follows:

Sanitation - control of all conditions which contribute to contamination and may permit the spread of disease or infection, the irritation, discomfort or impairment of bodily function through inhalation, ingestion or contact.

Safety - control of all conditions relating to prevention of accidents or catastrophy which could cause personal injury or property damage.

Security - Prevention of unauthorized access to waste handling and disposal areas to eliminate pilferage or salvage of hazardous wastes and accidental contact with contaminated materials.

Esthetics - Public and users acceptability in terms of appearance, noise, odors, psychological factors, convenience, workability of the system, etc.

Development of methods for evaluation of solid waste systems for the various types of special purpose buildings under study was based on observations of their respective operating characteristics, requirements and types of material being handled. It was obvious that types of wastes and handling requirements differed extremely between building classifications, and that methods of evaluation would necessarily be tailored to each group.

Identification and Point of Origin of Hospital Waste Materials:

Types of conventional solid wastes generated in hospital plants are not unlike those wastes to be found in small municipalities and may include:

1. Garbage
2. Rubbish
3. Ashes
4. Dead Animals
5. Special Wastes
6. Bulky Wastes (furnishings, auto parts, tires, etc.)
7. Expended Vehicles
8. Street and Landscaping Refuse
9. Construction and Demolition Wastes
10. Industrial Wastes (shops)

In addition, reusable materials and equipment, such as linens, food service items, patient care items, etc. requiring reprocessing, often will be found in quantities that far exceed the amounts of these conventional solid wastes.

Generally, bulky wastes, worn-out vehicles, street and landscaping refuse, construction and demolition wastes, not uncommon on hospital sites, are handled in separate channels apart from the main flow of waste materials generated daily within the plant buildings. Daily quantities of these materials generated fluctuate considerably. Dependent on the nature and quality of these materials, they may be salvaged for in-plant reuse or deposited at landfills. By and large, the methods of disposal generally selected are limited by the characteristics of the individual waste materials. Detailed studies of these types of wastes will not be considered within this study, except as they may be found within the building waste handling system. Similarly, those radiological wastes which are generated in varying quantities and handled in compliance with State and Federal regulations will not be investigated in depth except as they may affect the general waste handling system in the hospital complex.

In summary, the identification of kinds of wastes that may be found normally in the main stream of the solid waste system include garbage, rubbish, ashes, dead animals, special wastes and reusables. From observations of the different characteristics of certain waste materials and their respective handling requirements within the hospital waste system, eight categories of waste materials have been established for detailed study. These categories are identified as follows:

1.	Sharps - needles, blades, etc.	(Disposable)
2.	Surgical, pathological and animals	(Disposable)
3.	Soiled linen	(Reusable)
4.	Rubbish or mixed refuse	(Disposable)
5.	Patient care items	(Reusable)
6.	Non-combustible - glass, metals and ashes	(Disposable)
7.	Garbage (Non-grindable)	(Disposable)
8.	Food service items	(Reusable)

For further background on the development of evaluation methods, some comment on the identification of the various types of waste materials and their point-of-origin is necessary. Wide variations in departmental organization exist; however, for purposes of this presentation and from review of available organizational charts, departmentalization as illustrated in Table III-1 has been adopted as generally representative of hospitals in the total system, and is indicative of the range of points-of-origin of waste materials. Table III-1 also illustrates the major identifiable types of solid wastes that may be generated in typical departmental areas, and designates these materials as either contaminated or non-contaminated. With limited exceptions, contaminated wastes are generated in the medical departments (patient care areas and services) as opposed to the generation of non-contaminated wastes occurring in non-medical departments. Those classifications as shown in the Table are based on the definitions of contaminated and non-contaminated wastes presented earlier in this report.

Composition of Solid Waste Systems in Hospitals:

Functions of waste handling, storage, processing and disposal in the total solid waste system may be accomplished by using various combinations of methods and equipment. Table III-2 lists typical variables that may occur in performance of each major function in the Unit, Inter-Unit, Inter-Building and Off-Site System.

Generally, the more conventional methods and equipment are employed in the hospitals under study, and considerable variations within the systems occur at each

TABLE III-1 TYPES OF WASTES PRODUCED BY DEPARTMENTS

SOURCE OF WASTE	TYPES OF WASTE MATERIALS																	
	DISPOSABLES														REUSABLES			
DEPARTMENT	Radiological	Pathological & Surgical	Small Animals	Sharps (Needles, Blades, Etc.)	Mixed Refuse Combustible	Segregated Non-Combustible	Food Waste Grindable	Food Waste Non-Grindable	Patient Care Items	Food Service	Linens	Garden Trash	Demolition Waste	Ash and Residue	Bottles	Patient Care Items	Food Service	Soiled Linen
Non-Medical Departments																		
Administration					nc													
Resident Facilities					nc													c
Engineering					nc								nc					
General Services					nc	nc						nc		nc	nc			
Laundry					c	c												c
Dietary					c	nc	c	nc		c							c	
Medical Departments																		
Clinical Services																		
Acute & Ext. Care		c		c	c	c	c		c	c	c				c	c	c	c
Obstetrics & Gyn.		c		c	c	c	c		c	c	c				c	c	c	c
Out-Patient	c	c		c	c	c			c		c				c			c
Pediatrics				c	c	c	c		c	c	c				c	c	c	c
Psychiatrics				c	c	c	c		c	c	c				c	c	c	c
Surgery		c		c	c	c					c				c			c
Support Services																		
Clinical Laboratory		c		c	c	c					c				c			c
Research Laboratory	c	c	c	c	c	c					c				c			c
Dental Clinic				c	c	c					c				c			c
Radiology					c	c					c							c
Pathology		c		c	c	c												
Pharmacy				c	c	c									c			c

Note: Above Designation of Wastes Indicates Departmental Locations Where Contaminated (c) and Non-Contaminated (nc) Wastes are Generated

TABLE III-2 TYPICAL VARIABLES IN COMPOSITION OF SOLID WASTE SYSTEMS

Unit System			Inter-Unit System		Inter-Building System			Off-Site System	
Initial Deposit (Receiver)	Initial Transfer	Initial Storage, Processing, Disposal	Vertical Transfer	Intermediate Storage, Processing, Disposal	Internal Transfer	Central Storage	Central Processing or Disposal	External Transfer	Final Processing and/or Disposal
Open Container	Manual	None	Gravity Chute	None	Manual	None	None	Open Truck	Landfill
Open Container w/Liner	Hand Cart	Sealing Contained Liner	Elevator	Storage Room and/or Bins	Hand Cart	Piles or Pits	Incinerate	Covered Truck	Sanitary Landfill
Disposable Container	Pneumatic Tube	Compact	Dumb-waiter	Compact	Motorized Cart or Train	Open Container	Grind or Pulp	Packer Truck	Special Sanitary Landfill
Special Container	Automated Conveyor	Encap-sulate	Automated Conveyor	Encap-sulate	Automated Conveyor	Closed Container	Shred	Container Carrier	Incinerate
Closed Container	Motorized Cart	Grind or Pulp	Pneumatic Tube	Grind or Pulp	Pneumatic Tube	Compactor Container	Compact	Sewer	Sewage Treatment Plant
Closed Container w/Liner		Storage Room	Pipeline	Incinerate	Pipeline	Holding Tank	Extractor		Discharge to Sea
		Reclaim for Reuse		Reclaim for Reuse	Truck	Storage Room	Reclaim for Reuse		Salvage

hospital in handling different kinds of wastes, such as grinding of food preparation wastes, incineration or grinding of pathologic wastes, segregation in handling of certain types of wastes upon creation through their disposal.

Table III-3 serves to illustrate these variations by showing the principal types of wastes handled at a typical local plant and the numerous "systems" that may exist for "special handling" of certain solid waste materials. Personal decisions and judgments, hurriedly made on some occasions, must channel a particular type of waste material into the right path for its proper handling. Due to error in personal judgment, a resulting intermix of materials in the various "systems" is not uncommon.

Without adequately supervised specialized personnel being assigned for the exclusive purpose of handling solid waste materials, numerous parallel systems for handling segregated wastes cannot be expected to function consistently in the manner intended, and avoid the intermix of contaminated and non-contaminated materials.

TABLE III-3

DESCRIPTION OF HOSPITAL SOLID WASTE SYSTEMS

			Unit System			Inter-Unit System		Inter-Building System			Off-Site System	
Type of Waste	Av. Daily Weight	% of Total	Initial Deposit (Receiver)	Initial Transfer	Initial Storage, Processing, Disposal	Vertical Transfer	Intermediate Storage, Processing, Disposal	Internal Transfer	Central Storage	Central Processing or Disposal	External Transfer	Final Processing and/or Disposal
Sharps, Needles, Etc.	75	.1	Lined Open Container	Manual	Utility Room	Elevator	Can Room	Cart Train	Cart	Loading Dock	Hospital Packer Truck	Landfill
Pathological and Surgical	1,000	1.3	Lined Closed Container	Manual	Utility Room	Elevator	Can Room	Cart Train	Cart	Loading Dock	Hospital Packer Truck	Landfill
Soiled Linen	45,500	58.6	Cloth Bag	Manual	Corridor	Gravity Chute	Chute Room	Cart Train	Open Storage Area	Laundry	---	---
Rubbish	16,200	20.9	Lined Open Container	Hand Cart	Utility Room	Gravity Chute	Chute Room	Cart Train	Cart	Loading Dock	Hospital Packer Truck	Landfill
Reusable Patient Items	---	---	---	Manual	Utility Room Autoclave	---	---	---	---	---	---	---
Non-Combustible	1,500	1.8	Lined Open Container	Manual	Utility Room	Elevator	Can Room	Cart Train	Cart	Loading Dock	Hospital Packer Truck	Landfill
Garbage (Non-Grindable)	1,800	2.3	Special Cart	Special Cart	Corridor	Elevator	Corridor	Cart Train	Special Cart	Loading Dock	Hospital Packer Truck	Landfill
Food Service Items	9,000	11.6	Special Cart	Special Cart	Corridor	Elevator	Corridor	Cart Train	Corridor	Kitchen	---	---
Radiological	TR	TR	Special Container	Manual	Special Container	Elevator	---	Hand Cart	Roof Top	---	Private Contractor	Federal Landfill
Ash & Residue	TR	TR	Closed Container	Manual	---	Stairs	Can Room	Cart Train	Cart	Loading Dock	Hospital Packer Truck	Landfill
Animal Carcasses	25	TR	Closed Container	Manual	---	---	---	Cart	Refrigerator	---	City Truck	Rendering
Food Waste (Grindable)	2,600	3.4	Open Container	Manual	Grinder	Sewer	---	Sewer	---	---	Sewer	Sewer Treatment Plant

Community Interrelationship to the Hospital Waste System:

Other factors to consider in the evaluation process include environmental contamination within the community. No conclusive research directly related to off-site disposal of hospital wastes and its effect on the community has been performed. Principal concerns relate to the possible survival of harmful bacteria and disease transmission by direct human contact with contaminated materials or through other biological vectors, as well as transmission through air and water pollution. Off-site disposal conventionally involves a method of highway transport, direct or via transfer stations to landfills, central incineration plants or other disposal facilities. The community environment may be exposed to hospital waste contaminants throughout the course of travel with greatest potential exposure occurring at the disposal site where direct contact by refuse workers and scavengers may occur or where water pollution via run-off or leaching may ultimately affect the populace. Potential hazards to the environment may be minimized in transport through tight containerization, and at disposal sites through special handling procedures, tight security and proper selection of site. In practice, all these measures are difficult to insure.

Though beyond the scope of this study, it was considered necessary to identify and convey the relative significance of the hospital waste disposal problem within Los Angeles County. Figure III-1 illustrates the subdivision of Los Angeles County by health districts as identified by the County Health Department. Table III-4 shows the 1968 distribution of hospital beds and nursing home beds within the County by these districts. Using nominal waste production factors of 10 lbs./day per hospital bed patient and 5 lbs./day per nursing home bed patient, a potential quantity of about 470,000 lbs. or 235 tons of disposable wastes can be expected to be generated daily in Los Angeles County. Other than identified pathologic wastes which represent a small percentage of total wastes, it is likely the majority of these waste materials are being transported to area landfills. It is also likely that the majority of hospitals, especially those of less than 500 beds, are serviced by private refuse contractors. Largely these waste materials are not identifiable as hospital wastes as they are received at landfills. Private contractors servicing the majority of private institutions as well as some of the public facilities contract for routine servicing, and of course no segregated collection is feasible. Therefore, the majority of hospital wastes are mixed with commercial wastes prior to delivery to disposal sites and do not receive special handling.

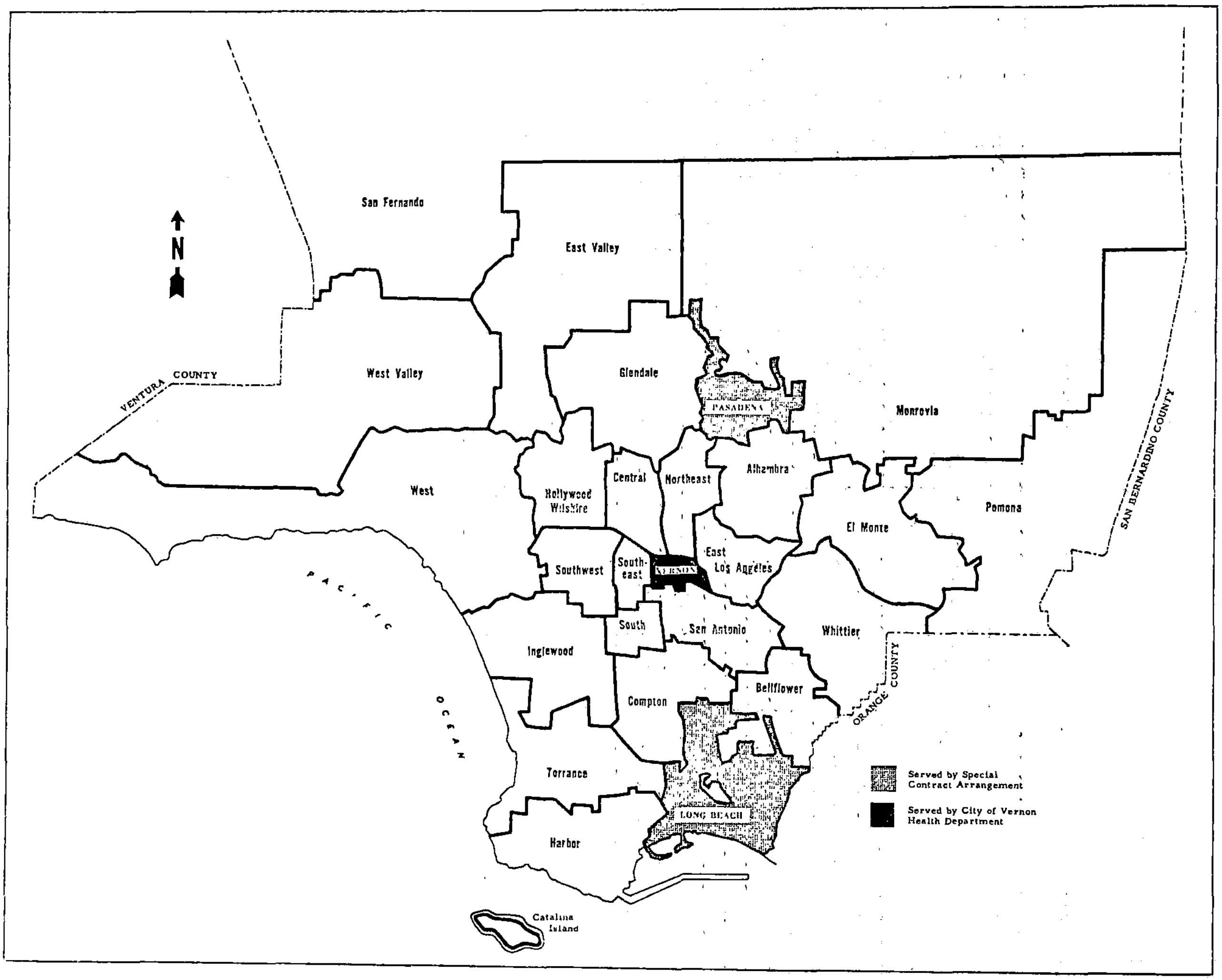

Figure III-1.

HEALTH DISTRICTS County of Los Angeles Health Department

TABLE III-4 DISTRIBUTION OF HOSPITALS AND NURSING HOMES - LOS ANGELES COUNTY 1968

Location of Facilities by Health Districts	HOSPITALS: No. of Hospitals by Capacity Range					HOSPITALS: Total		NURSING HOMES (N.H.): No. of Nursing Homes by Capacity Range			NURSING HOMES (N.H.): Total		Combined Total	
	0-49 Beds	50-99 Beds	100-299 Beds	300-499 Beds	500+ Beds	No. of Hosps.	No. of Beds	0-49 Beds	50-99 Beds	100+ Beds	No. of N.H.	No. of Beds	No. of Facilities	No. of Beds
Alhambra		3	1			4	427	9	11	2	22	1,519	26	1,946
Bellflower	3	5	2			10	793	2	7	1	10	776	20	1,569
Central	3	4	2	3		12	1,925	11	9	4	24	1,685	36	3,605
Compton	3		1		1	5	716	4	7	3	14	1,170	19	1,886
East Los Angeles	1	2	1			4	295	1	2	1	4	428	8	723
El Monte	2	2				4	243	5	10	2	17	1,402	21	1,645
East Valley		4				4	306	8	8	1	17	939	21	1,245
Glendale	2	1	3	2		8	1,388	12	10	6	28	1,909	36	3,297
Harbor		1	3			4	491		2		2	179	6	670
Hollywood-Wilshire	2	3	2	2	1	10	2,112	14	15	2	31	1,783	41	3,895
Inglewood	3	4	4			11	1,150	2	10	2	14	1,145	25	2,295
Long Beach	1	3	2	3	1	10	2,388	7	10	3	20	1,442	30	3,830
Monrovia	4	2	3			9	1,052	10	11	1	22	1,328	31	2,380
Northeast	3	2	2		1	8	2,828	3	6	3	12	907	20	3,735
Pasadena		2	1	1		4	748	7	16	1	24	1,484	28	2,232
Pomona	3	2	2	1		8	1,047	11	12		23	1,277	31	2,324
San Antonio	3	3	1		1	8	2,026	3	1		4	175	12	2,201
San Fernando	4	1	5		1	11	1,873	3	7	1	11	1,000	22	2,873
South		1				1	67	1			1	30	2	97
Southeast	2		2			4	492	2	1		3	143	7	635
Southwest	5	4				9	481	7	10	1	18	1,177	27	1,658
Santa Monica	1	3	2	2		8	1,479	9	14	4	27	1,814	35	3,293
Torrance	1	2	2		1	6	1,257	2	6	4	12	1,149	18	2,406
Vernon						0	0				0	0	0	0
West Valley	3	5	7			15	1,651	6	11	3	20	1,475	35	3,126
Whittier		2	2			4	569	2	3	5	10	978	14	1,547
TOTAL (Excluding Veterans Administration Facilities)	49	61	50	14	7	181	27,804	141	199	50	390	27,314	571	55,118
Veterans Administration Hospitals (5)							3,397					4,502		7,899
TOTAL BEDS							31,201					31,816		63,017

Again assuming that contamination of the environment may result from off-site transport and disposal of this material, it may be emphasized that geographically nearly all areas of the County are subject to this potential hazard.

Based on the above factors and limited knowledge in this field as to immediate and long-range effects, elimination of these potential hazards to the community environment through on-site disposal would likely be recognized as the preferred method from the viewpoint of public interest. Prevailing methods of on-site disposal are basically limited to grinding of food wastes and incineration. Destruction of hospital wastes by on-site incineration, while eliminating major potentials of disease transmission, may also contribute to the added problem of community air pollution through emissions. Grinding of food wastes with discharge to sewer is unquestionably one of the most efficient processes and least offensive to both the operating personnel and the community at large. Exploration needs to be made on potentials of grinding all wastes for sewage discharge and decontamination of these materials before removal from the hospital plant.

Regardless of the system selected, assurance of its proper operation to minimize environmental contamination, both within the plant and the community, is paramount and is emphasized in the development of the evaluation methods.

Evaluation of Hospital Solid Waste Systems:

For the complex systems generally found in hospitals, it appeared necessary and desirable to develop a numerical rating method that would consider the relative value of environmental factors, the relative effect or hazard of each type of waste on the environmental factors and the significance of each waste in the total system. Table III-5, developed through collaboration with knowledgeable parties, numerically illustrates the above factors. Through arithmetical calculations, the cumulative value of some 4,300 points was established and identified as the maximum value of the hospital system.

It also appeared necessary to relate the significance of each waste to each component and function within the system in order to convey the identity and location of inadequacies that may be found. Table III-6 identifies the eight principal groups of solid waste materials, presents the breakdown of each system by components (Unit, Inter-Unit, Inter-Building and Off-Site systems) and the related functions within each component. Distribution of the total weighted numerical value of each waste from Table III-5 is made to each of the ten functions in the total system and the respective environmental factors (sanitation, safety, security and esthetics). These numerical values appearing in Table III-6 were based on judgments of the relative significance of each waste as it affects the respective environmental factors within each function of each waste system. The format of Table III-6 was developed not only to illustrate the distribution of maximum values within the waste system but also to provide a tool for actual rating of those systems of the hospitals under study.

In practice, the actual rating evolved as a grading process which reflected the deficiency in operation of each required function in the total system. This deficiency point rating method was resolved to a five-step grading process, considering both equipment and methods employed in the performance of each function. Actual rating of a system function involved calculation of deficiency points applicable to each environmental factor in each function. Blank spaces indicate a function not applicable to the system. Conditions and accompanying deficiencies (related to maximum values) in the adopted grading process are as follows:

Condition	Deficiency
Need Not Be Improved. Completely Acceptable As Is.	- 0% of Maximum Value
Requiring Some Improvement in Method of Operation. Equipment is Adequate for Intended Use	- 25% of Maximum Value
Requiring Major Improvements in Method of Operation and Some Improvement in Equipment Maintenance	- 50% of Maximum Value
Requiring Major Improvements in Method of Operation and Major Improvement in Repair and Replacement of Equipment	- 75% of Maximum Value
System Is Not Acceptable for Present Use and Major Equipment Design Changes Are Required	-100% of Maximum Value

TABLE III-5 BASIS OF EVALUATION OF HOSPITAL SOLID WASTE SYSTEMS

Relative Values (A)	4		3		2		1		10
Environmental Factor	Sanitation		Safety		Security		Esthetics		Total
Type of Waste	(B)	(C)	(B)	(C)	(B)	(C)	(B)	(C)	
Sharps, Needles, Etc.	90	360	100	300	100	200	65	65	925
Surgical, Pathological & Animals	75	300	25	75	100	200	100	100	675
Soiled Linen	100	400	25	75	47	95	100	100	670
Reusable Patient Items	40	160	40	120	60	120	50	50	450
Rubbish	40	160	75	225	62	125	100	100	610
Non-Combustible	30	120	50	150	42	85	55	55	410
Garbage	24	95	18	55	25	50	100	100	300
Food Service	20	80	26	80	25	50	50	50	260
TOTAL VALUE OF OPTIMUM SYSTEM		1675		1080		925		620	4300

(A) Relative Values of Environmental Factors

(B) Relative Significance of the Particular Environmental Factor for the Particular Waste (Rating on Scale of 0 to 100)

(C) Weighted Numerical Value (C=AB) of Each Waste or its Relative Significance to Each Environmental Factor and the Total System

TABLE III-6 NUMERICAL RATING OF HOSPITAL SOLID WASTE SYSTEMS

Type of Waste		Unit System: Initial Deposit (Receiver) Def. Value	Unit System: Initial Deposit (Receiver) Max. Value	Unit System: Initial Transfer Def. Value	Unit System: Initial Transfer Max. Value	Unit System: Initial Storage, Processing, Disposal Def. Value	Unit System: Initial Storage, Processing, Disposal Max. Value	Unit System: Def. Value Total	Unit System: Max. Value Total	Inter-Unit System: Vertical Transfer Def. Value	Inter-Unit System: Vertical Transfer Max. Value	Inter-Unit System: Intermediate Storage, Processing, Disposal Def. Value	Inter-Unit System: Intermediate Storage, Processing, Disposal Max. Value	Inter-Unit System: Def. Value Total	Inter-Unit System: Max. Value Total	Inter-Building System: Internal Transfer Def. Value	Inter-Building System: Internal Transfer Max. Value	Inter-Building System: Central Storage Def. Value	Inter-Building System: Central Storage Max. Value	Inter-Building System: Central Processing or Disposal Def. Value	Inter-Building System: Central Processing or Disposal Max. Value	Inter-Building System: Def. Value Total	Inter-Building System: Max. Value Total	Off-Site System: External Transfer Def. Value	Off-Site System: External Transfer Max. Value	Off-Site System: Final Processing and/or Disposal Def. Value	Off-Site System: Final Processing and/or Disposal Max. Value	Off-Site System: Def. Value Total	Off-Site System: Max. Value Total	Def. Value Total	Max. Value Total
Sharps, Needles, Etc.	Sanitation		40		50		20		110		50		20		70		50		10		20		80		20		80		100		360
	Safety		40		50		10		100		45		10		55		45		5		10		60		10		75		85		300
	Security		30		5		25		60		5		25		30		5		25		10		40		10		60		70		200
	Esthetics		5		5		5		15		5		5		10		5		5		5		15		5		20		25		65
Surgical, Pathological & Animals	Sanitation		20		35		35		90		20		35		55		10		10		40		60		20		75		95		300
	Safety		5		10		5		20		5		10		15		15		10		5		30		5		5		10		75
	Security		5		5		35		45		5		35		40		5		20		5		30		10		75		85		200
	Esthetics		10		5		15		30		5		15		20		5		15		10		30		5		15		20		100
Soiled Linen	Sanitation		40		50		30		120		80		50		130		30		30		40		100		10		40		50		400
	Safety		5		5		5		15		5		5		10		10		5		15		30		5		15		20		75
	Security		5		5		5		15		5		15		20		15		20		5		40		15		5		20		95
	Esthetics		20		15		10		45		10		10		20		5		5		5		15		5		15		20		100
Rubbish	Sanitation		5		10		10		25		20		15		35		10		10		15		35		10		55		65		160
	Safety		15		20		25		60		20		45		65		15		25		25		65		10		25		35		225
	Security		5		5		20		30		5		15		20		5		15		10		30		15		30		45		125
	Esthetics		15		15		10		40		10		10		20		5		5		5		15		10		15		25		100.
Reusable Patient Items	Sanitation		15		20		25		60		15		15		30		20		10		15		45		10		15		25		160
	Safety		15		20		5		40		15		5		20		15		5		15		35		10		15		25		120
	Security		15		5		15		35		5		15		20		10		15		15		40		10		15		25		120
	Esthetics		5		5		5		15		5		5		10		5		5		5		15		5		5		10		50
Non-Combustible	Sanitation		5		10		10		25		15		5		20		5		5		5		15		5		55		60		120
	Safety		20		15		20		55		15		20		35		10		10		10		30		5		25		30		150
	Security		10		5		15		30		5		10		15		5		10		5		20		5		15		20		85
	Esthetics		10		5		5		20		5		5		10		5		5		5		15		5		5		10		55
Garbage (Non-Grindable)	Sanitation		5		5		15		25		5		15		20		5		5		15		25		10		15		25		95
	Safety		5		5		5		15		5		5		10		5		5		5		15		5		10		15		55
	Security		5		5		5		15		5		5		10		5		5		5		15		5		5		10		50
	Esthetics		15		5		10		30		5		10		15		5		10		5		20		15		20		35		100
Food Service Items	Sanitation		5		5		10		20		5		10		15		5		5		15		25		5		15		20		80
	Safety		10		10		10		30		5		10		15		5		5		10		20		5		10		15		80
	Security		5		5		5		15		5		5		10		5		5		5		15		5		5		10		50
	Esthetics		5		5		5		15		5		5		10		5		5		5		15		5		5		10		50
Total	Sanitation		135		185		155		475		210		165		375		135		85		165		385		90		350		440		1675
	Safety		115		135		85		335		115		110		225		120		70		95		285		55		180		235		1080
	Security		80		40		125		245		40		125		165		55		115		60		230		75		210		285		925
	Esthetics		85		60		65		210		50		65		115		40		55		45		140		55		100		155		620
TOTAL			415		420		430		1265		415		465		880		350		325		365		1040		275		840		1115		4300

Evaluation of Systems in Other Building Types:

In contrast to hospital waste systems, characteristics of solid waste systems in detention facilities and office buildings are relatively simple. Although these systems are similar in structure, the types and relative quantities of wastes they must handle are considerably less. In addition, the characteristics of the waste materials are less offensive and hazardous and require minimum segregation in handling and storage. Even though these systems are relatively simple, it appeared necessary to develop similar evaluation methods (numerical ratings) as prepared for hospitals, as a means of identifying and conveying our findings.

In the case of detention facilities inspected, identifiable components of the system were limited to the inter-unit or inter-building and off-site system. Identifiable wastes consistently found in the mainstream of this principal system are soiled linens, garbage and rubbish. Through a similar process as detailed in the discussion on evaluation of hospital systems, the rating method considers the relative value of environmental factors (in this case equal), the relative effect or hazard of each type of waste on the environment and the significance of each waste in the system. Table III-7 was developed establishing the cumulative value of 1,000 points as the maximum value of the detention facility system.

TABLE III-7 BASIS OF EVALUATION OF DETENTION FACILITY SYSTEMS

Relative Value (A)	1	1	1	1	4
Environmental Factor	Sanitation	Safety	Security	Esthetics	Total
Type of Waste	(B)	(B)	(B)	(B)	(C)
Soiled Linen	100	60	80	100	340
Garbage	80	60	60	100	300
Rubbish	60	100	100	100	360
Total	240	220	240	300	1000

(A) Relative Value of Environmental Factors
(B) Relative Significance of Each Waste on Each Environmental Factor
(C) Relative Significance of Each Waste in Total System

Table III-8 identifies the three principal wastes and relates the significance of each within each component of the system and functions within the components. Distribution of the total numerical value of each waste from Table III-7 is made to each of the five functions in the total system and the respective environmental factors.

In the case of office buildings inspected, identifiable components of the systems included the unit, inter-unit and off-site systems. In these systems, the general practice employed mixes all wastes as collected and virtually no segregation of waste materials occurs. The relative value of environmental factors are considered equal. Table III-9 was developed, establishing a 400 point maximum value of the office building system. Distribution of this value is made to each of the three system components and respective functions of these components, as well as environmental factors within each function.

The rating forms illustrating the distribution of maximum values within the waste systems are later employed in the actual rating of those systems in detention facilities and office buildings under study. The method of rating of these systems is on a deficiency basis following the same procedures as set forth earlier in the discussion on evaluation of hospital systems.

TABLE III-8 NUMERICAL RATING OF DETENTION FACILITY SOLID WASTE SYSTEMS

System Components			Soiled Linen		Garbage		Rubbish		Total		TOTAL	
			Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value
Inter-Unit or Inter-Building System	Internal Transfer	Sanitation		25		5		20		50		160
		Safety		10		15		15		40		
		Security		5		10		15		30		
		Esthetics		15		10		15		40		
	Central Storage	Sanitation		10		5		5		20		195
		Safety		10		5		25		40		
		Security		20		10		30		60		
		Esthetics		20		25		30		75		
	Central Processing or Disposal	Sanitation		15		20		15		50		185
		Safety		10		20		20		50		
		Security		15		10		15		40		
		Esthetics		15		15		15		45		
	Total	Sanitation		50		30		40		120		540
		Safety		30		40		60		130		
		Security		40		30		60		130		
		Esthetics		50		50		60		160		
Off-Site System	External Transfer	Sanitation		20		20		5		45		195
		Safety		15		15		20		50		
		Security		15		15		15		45		
		Esthetics		20		20		15		55		
	Final Processing and/or Disposal	Sanitation		30		30		15		75		265
		Safety		15		5		20		40		
		Security		25		15		25		65		
		Esthetics		30		30		25		85		
	Total	Sanitation		50		50		20		120		460
		Safety		30		20		40		90		
		Security		40		30		40		110		
		Esthetics		50		50		40		140		
	TOTAL	Sanitation		100		80		60		240		1000
		Safety		60		60		100		220		
		Security		80		60		100		240		
		Esthetics		100		100		100		300		

TABLE III-9 NUMERICAL RATING OF OFFICE BUILDING SOLID WASTE SYSTEMS

System Components			RUBBISH		Total	
			Def. Value	Max. Value	Def. Value	Max. Value
UNIT SYSTEM	Initial Deposit (Receiver)	Sanitation		10		40
		Safety		5		
		Security		5		
		Esthetics		20		
	Initial Transfer	Sanitation		10		30
		Safety		5		
		Security		5		
		Esthetics		10		
	Initial Storage, Processing, Disposal	Sanitation		5		55
		Safety		15		
		Security		15		
		Esthetics		20		
	Total	Sanitation		25		125
		Safety		25		
		Security		25		
		Esthetics		50		
INTER-UNIT SYSTEM	Internal Transfer	Sanitation		25		60
		Safety		15		
		Security		10		
		Esthetics		10		
	Central Storage	Sanitation		10		75
		Safety		25		
		Security		30		
		Esthetics		10		
	Central Processing or Disposal	Sanitation		15		40
		Safety		10		
		Security		10		
		Esthetics		5		
	Total	Sanitation		50		175
		Safety		50		
		Security		50		
		Esthetics		25		
OFF-SITE SYSTEM	External Transfer	Sanitation		10		30
		Safety		10		
		Security		5		
		Esthetics		5		
	Final Processing and/or Disposal	Sanitation		15		70
		Safety		15		
		Security		20		
		Esthetics		20		
	Total	Sanitation		25		100
		Safety		25		
		Security		25		
		Esthetics		25		
TOTAL		Sanitation		100		400
		Safety		100		
		Security		100		
		Esthetics		100		

Improvements in Systems:

Rating of the waste system has been resolved to evaluation of that system actually employed in handling each of the identifiable wastes and the capability of that system to consistently handle the material in an acceptable manner. This concept of evaluation provides for a rating, reflecting (1) capabilities of the system and its equipment and (2) efficiency of operating technique. This evaluation is expressed by application of deficiency points to individual functions and collectively represent a deficiency rating of the total system. Guidelines for needed improvements to the existing system would be indicated by the deficiency ratings of each waste in the unit, inter-unit, inter-building and off-site systems. Considered system improvements to reduce system deficiencies may be classified as interim or long range in nature.

Interim improvements or remedial measures involving minimal expenditures may range from greater emphasis on equipment maintenance or stop-gap training measures to improve the techniques of operating personnel to replacement or modification of obsolete equipment.

Emphasis on long range improvements must consider new technology and concepts of the various "closed system" concepts and totally integrated systems which may minimize malfunctioning. The "closed system" approach may include combinations of material handling, processing and disposal devices which eliminate or minimize human handling of solid wastes after the initial deposit. With the flow of all solid waste materials in hospitals nearly paralleling the flow of clean supplies and equipment (both in quantity and routes, except in the return cycle), the "closed system" concept may also include consideration of those multi-purpose material handling systems being developed for building application.

In later stages of this study where system improvements are considered in these local buildings, the same method of evaluation used in the rating of existing systems will also be applied in the rating of contemplated modifications.

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Comparison of Hospital Solid Waste Systems

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Comparison of Detention Facility Solid Waste Systems

Comparison of Office Building Solid Waste Systems

A comprehensive review, inventory and evaluation of existing solid waste systems and solid waste management practices in a substantial cross section of County owned and operated building complexes within the County of Los Angeles were carried out during the early stages of this study. Complete details of these investigations were recorded in Volume II. In review of this volume of material, the following digest has been prepared restating the purpose and scope of the total study, as well as briefly summarizing investigations conducted at these local institutions.

RESTATEMENT OF PURPOSE AND SCOPE OF STUDY

The ultimate purpose of the total study is to determine improved solid waste handling, storage, processing and/or disposal techniques adaptable to various types of multi-story buildings and building complexes. In connection with these objectives, a comprehensive investigation of existing systems, methods, and practices in various types and sizes of buildings was required as the initial phase of study. A wide range of building classifications was initially considered. However, due to anticipated details of study and time limitations, only three basic building classifications were approved for study within the scope of the contract. These classifications, hospitals, detention facilities and office buildings, were selected based on their diverse functions and apparent differences in solid waste system requirements. Selection of the individual projects included seven hospitals, five detention facilities and four office buildings. Extreme variations in physical configurations, functions and waste system requirements also existed in those projects selected within each building classification.

Separate survey methods and report formats were developed for each building classification to record and convey pertinent data on identification of the existing solid waste systems, classification of wastes, quantities of waste production, operating characteristics and cost analysis of the systems, as well as evaluation of the environmental effect of systems operation within each plant and the community at large.

Procedures for the evaluation of solid waste systems were developed by the project staff under the guidance of special consultants in environmental health and staff members of the School of Public Health, University of Minnesota. Field observations and ratings were carried out at each of the local projects by the observation team consisting of the Project Engineer, his assistant and a field engineer representing the County Engineer's office. Individual ratings of each project were made by each member of the observation team. Differences in judgments were reconciled through discussion and additional site visits. Results of these evaluations were reviewed by the above-noted advisors who is some cases made independent evaluations to corroborate the ratings as presented in this report.

As indicated above, Volume II presented comprehensive detail of these observations. Chapters II through VIII (Volume II) presented individual reviews on the relatively complex hospital solid waste systems, and Chapters IX and X (Volume II), respectively, presented studies of systems operations at detention facilities and office buildings. Similarity of waste system characteristics within these latter building categories permitted the presentation of the investigations in an abbreviated form by building categories rather than individual projects. A summary of these project reports are incorporated herein.

A case study of the LAC-USC Medical Center, illustrating typical details involved in these investigations, as reported in Chapter II, Volume II, is appended (Appendix A) in its entirety for the readers' information.

SOLID WASTE SYSTEMS IN COUNTY HOSPITALS

Investigations of all the selected County hospitals were conducted during the latter months of 1968 and early 1969 to determine physical characteristics of the plants and develop data on the solid waste systems. Diverse conditions found to exist among nearly all plants ranged not only from the physical characteristics of location, land, buildings and plant layout, but also to the predominant types of care and specialties each facility offers.

Initial field observations were carried out at each of these hospitals to determine average daily quantities and types of wastes produced. Observations ranged from a period of five days to two weeks at these plants, depending on the size and complexity of the waste system operation. Weight records were developed on all major types of disposable wastes through the use of portable scales. Daily weight records of soiled linen were obtained from laundry records for all hospitals. Results of these observations were compiled and typical daily activity was estimated for each plant as shown in Table IV-1. This Table provides the breakdown of daily waste production by type of waste and summarizes total daily production by the broad categories of disposable and reusable waste materials, as well as certain calculated unit production factors (daily bed patient and per capita production). Although waste production in hospitals is commonly reduced to the familiar "pounds per bed patient unit", the results of this study of the seven local hospitals have shown an extremely wide range in unit production when analyzed on this basis. This analysis suggests that for estimating purposes in the design of solid waste systems, calculations of total wastes based on bed patient capacity alone may be misleading and that further investigations should be made relating production to other plant and building characteristics.

An example of the wide range in waste quantities generated when analyzed on daily production/bed patient/day can best be illustrated by a comparison between Long Beach General Hospital and the LAC/USC Medical Center as shown on Table IV-1. Long Beach, a geriatrics center, offers a type of patient care that requires limited specialties, limited space, limited supplies, limited staff and support personnel as opposed to the requirements of the Medical Center. The Medical Center is one of the major general teaching hospitals in the country. This institution provides a comprehensive range of medical care for all age groups. Highly specialized services require a complex plant with a high ratio of specialized building areas, supplies, staff and support personnel. With such varying conditions, it can best be summarized that types of wastes produced and respective quantities of each are to a great extent dependent upon the classification of the hospital (range and type of care), ratio of bed patients to equivalent population, and management policy on reusable and single-use items.

Comparison of Hospital Solid Waste Systems

TABLE IV-1 BREAKDOWN OF DAILY WASTE PRODUCTION (LBS./DAY) BY TYPES OF WASTE

Type of Waste	LAC-USC Medical Center	Long Beach General Hospital	Harbor General Hospital	Rancho Los Amigos Hospital	John Wesley Hospital	Olive View Hospital	Mira Loma Hospital
Sharps, Needles, Etc.	75	3	22	40	8	20	5
Path. & Surgical	1,000	TR	156	4	115	6	TR
Soiled Linen (R)	45,500	3,740	13,600	16,320	2,900	5,630	1,120
Rubbish	16,200	540	6,569	2,760	717	1,722	362
Reusable Patient Items (R)	TR	TR	TR	TR	TR	TR	TR
Non-Combustibles	1,500	75	465	725	80	250	80
Garbage (Non-Grindable)*	1,800	150	660	875	160	475	110
Food Service Items (R)	9,000	1,400	2,400	4,200	800	2,500	600
Radiological	TR	-	TR	TR	-	TR	-
Ash & Residue	TR	-	20	20	50	20	25
Animal Carcasses	25	-	220	20	10	23	-
Food Waste (Grindable)	2,600	330	950	1,100	210	1,860	150
TOTAL PRODUCTION	77,700	6,238	25,062	26,064	5,050	12,506	2,452
DAILY PRODUCTION DISPOSABLE	23,200	1,098	9,062	5,544	1,350	4,376	732
Pounds per Bed Patient	11.6	3.6	16.7	6.0	7.9	7.8	5.1
Pounds per ** Capita	3.75	2.08	5.57	2.80	3.44	4.32	3.37
DAILY PRODUCTION REUSABLE (R)	54,500	5,140	16,000	20,520	3,700	8,130	1,720
Pounds per Bed Patient	27.2	16.9	29.6	22.1	21.7	14.5	11.9
Pounds per ** Capita	8.75	9.74	9.73	10.20	9.41	8.08	7.93

*Predominantly Garbage Mixed with Substantial Quantities of Paper, Plastics, Metal, Etc.
**Per Capita Production Based on Equiv. 24-Hr. Population

Table IV-2 was prepared relating total waste production to building area, gross population (total patients, outpatients, employees, volunteer workers, etc.), and *equivalent population (average population present each 8 hour shift over 24 hours per day and 7 days per week).

Comparison of Hospital Solid Waste Systems

TABLE IV-2 CHARACTERISTICS OF HOSPITAL PLANTS AND DAILY WASTE PRODUCTION

	LAC-USC Medical Center	Long Beach General Hospital	Harbor General Hospital	Rancho Los Amigos Hospital	John Wesley Hospital	Olive View Hospital	Mira Loma Hospital	Range of Production (4)
Total Building Area (MSF)	2,822.0	195.4	665.8	1,191.0	140.3	510.1	91.1	
Bed Patient Capacity	2,300	428	688	1,540	259	699	232	
Ratio of Area (SF) per Patient	1,220	455	965	775	540	730	390	
Avg. Occupancy-Bed Patients(1)	2,018	302	541	929	170	560	144	
Occupancy Rate	87.4%	70.5%	78.6%	60.3%	65.5%	80.4%	62.1%	
Gross Population(2)	21,294	1,246	5,512	5,471	1,124	2,452	453	
Equivalent 24-Hr. Pop. (3)	6,220	526	1,645	1,982	392	1,012	217	
Ratio of Patients to Equiv. Pop.	32.3%	57.4%	32.8%	46.7%	43.4%	55.0%	66.5%	
Total Daily Waste Production (Lbs.)	77,700	6,238	25,062	26,064	5,050	12,506	2,452	
Lbs./MSF of Bldg. Area	25.6	32.0	32.5	21.9	36.0	24.5	27.0	64%
Lbs./Bed Patient	38.8	20.5	46.3	28.1	29.7	22.3	17.0	172%
Lbs./Person-Gr. Pop.	3.7	5.0	4.5	4.8	4.5	5.1	5.4	46%
Lbs./Capita-Equiv. Pop.	12.50	11.82	15.30	13.30	12.85	12.40	11.30	35%
Total Disposables (Lbs.)	23,200	1,098	9,062	5,544	1,350	4,376	732	
Lbs./MSF of Bldg. Area	7.5	5.6	10.7	4.7	9.6	8.6	8.2	128%
Lbs./Bed Patient	11.6	3.6	16.7	6.0	7.9	7.8	5.1	364%
Lbs./Person-Gr. Pop	1.1	0.8	1.6	1.0	1.2	1.8	1.6	125%
Lbs./Capita-Equiv. Pop.	3.75	2.08	5.57	2.80	3.44	4.32	3.37	168%
Total Reusables (Lbs.)	54,500	5,140	16,000	20,520	3,700	8,130	1,720	
Lbs./MSF of Bldg. Area	18.1	26.4	21.8	17.2	26.4	15.9	18.8	66%
Lbs./Bed Patient	27.2	16.9	29.6	22.1	21.7	14.5	11.9	149%
Lbs./Person-Gr. Pop.	2.6	4.2	2.9	3.8	3.3	3.3	3.8	62%
Lbs./Capita-Equiv. Pop.	8.75	9.74	9.73	10.20	9.41	8.08	7.93	29%

(1) Avg. Occupancy During Observation Period
(2) Gross Population Including Total Bed Patients, Outpatients, Employees, Volunteer Workers
(3) Equivalent Population is Average Shift Population Present 24 Hours per Day, 7 Days per Week
(4) Range in Production Over Lowest Production Factor

*Example of Calculations	Monday-Friday			Saturday and Sunday		
	1st Shift	2nd Shift	3rd Shift	1st Shift	2nd Shift	3rd Shift
Total Est. Population/Shift	13,400	5,100	4,300	5,000	3,500	3,500
Avg. Shift & Daily Pop.		7,100			4,000	

Equivalent Population = 5/7 (7,100) + 2/7 (4,000) = 5,075 + 1,145 = 6,220

A comparison of these calculated production factors, as shown in Table IV-2, indicates the following range in production occurring in the seven hospitals studied:

Lbs./MSF of Bldg. Area	- Ranging 64% above the low of 21.9 Lbs./MSF
Lbs. per Bed Patient	- Ranging 172% above the low of 17.0 Lbs./Bed Patient
Lbs./Person (Gross Pop.)	- Ranging 46% above the low of 3.7 Lbs./Person
Lbs./Capita (Equiv. Pop.)	- Ranging 35% above the low of 11.3 Lbs./Capita

This analysis indicates that estimates of waste production may be more accurately projected by using a per capita production factor related to equivalent population than the other production factors considered above. This analysis shows a range of 11.3 to 15.3 pounds per capita, including both disposable and reusable waste classifications, was generated daily at these hospitals studied. Table IV-2 also shows the calculated unit production factors individually for disposable and reusable waste classifications. Except for the distortion caused by the relatively low production level of disposable waste materials at Long Beach General Hospital, comparison of these factors further supports the theory that per capita production factors related to equivalent population provides the more reliable basis for estimating.

Continuing observations at these institutions were devoted to investigations of equipment and services provided for handling and disposal of solid wastes, and methods and practices employed, all as a basis for determination of costs of operation and evaluation of the systems.

Labor requirements were found to be the most significant factor in systems operation, consistently ranging above 90% of total operating costs. Table IV-3 illustrates the percentage distribution of costs represented by labor, building and fixed equipment, vehicular equipment, contractor or disposal fees, and miscellaneous expendable supplies. Percentage distribution of costs to the categories of reusable and disposable materials indicate a wide range of cost experience, some, such as Long Beach, with costs nearly in direct proportion to quantity of waste production, opposed to the cost experience of Harbor General, which is nearly in inverse proportion to quantities of reusables and disposables. In addition, total system costs are distributed to the

TABLE IV-3 PERCENTAGE DISTRIBUTION OF SYSTEMS OPERATING COSTS

	LAC-USC Medical Center	Long Beach General Hospital	Harbor General Hospital	Rancho Los Amigos Hospital	John Wesley Hospital	Olive View Hospital	Mira Loma Hospital
	% of Costs	% of Costs	% of Costs	% of Costs	% of Costs	% of Costs	% of Costs
SYSTEM COMPONENT							
Unit System	75.8	85.0	84.4	87.6	84.4	85.3	75.0
Inter-Unit System	14.1	-0-	6.0	2.5	7.8	3.9	18.0
Inter-Building System	4.3	10.0	5.2	9.1	7.8	9.7	5.0
Off-Site System	5.8	*5.0	4.4	.8	*TR	1.1	*2.0
Total System	100.0	100.0	100.0	100.0	100.0	100.0	100.0
COST ELEMENTS OF TOTAL SYSTEM							
Bldg. & Fixed Equip.	1.0	-0-	.4	.2	.4	.1	.5
Maint. & Repairs	0.3	-0-	.1	-0-	.1	.1	.1
Vehicular Equip. Carts	0.4	-0-	.3	.4	TR	.2	TR
Oper. & Maint.	1.2	-0-	1.2	1.3	TR	1.0	TR
Contract or Disposal Fees	0.7	1.1	.3	.3	.1	.2	.2
Misc. Expendable Supplies	1.5	6.4	1.9	2.2	6.2	1.9	4.2
Sub-Total	5.1	7.5	4.2	4.4	6.8	3.5	5.0
Labor	94.9	92.5	95.8	95.6	93.2	96.5	95.0
Total System	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CLASSIFICATION OF WASTE							
Disposable	54.1	29.2	69.3	56.2	55.5	55.0	42.5
Reusable	45.9	70.8	30.7	43.8	44.5	45.0	57.5
Total System	100.0	100.0	100.0	100.0	100.0	100.0	100.0

*Contract Services

sub-systems or system components (Unit, Inter-Unit, Inter-Building, and Off-Site system). It is of interest to note that the on-floor handling of waste (the Unit system) consistently ranges from 75 to 87.6% of total system costs.

To further signify the magnitude of labor in the systems operation, daily manpower requirements have been resolved to man minutes per bed patient as observed at each institution and shown in Table IV-4. Review of the individual description of solid waste systems and estimated daily labor costs of solid waste systems presented in the respective chapters will provide detail of these labor requirements at each institution.

Table IV-5 was prepared to relate estimated total costs of the system operation to quantities of waste produced. Unit cost data on a per ton basis, as well as on a bed patient day basis, has been calculated for comparison between hospitals.

The findings of this study, limited to detailed investigations at only seven hospitals, suggest that variations in labor requirements and total costs of operation are dependent largely on physical complexities of the plant layout and equipment employed, as well as the skill and inclination of labor. Development and evaluation of the foregoing statistics, together with observations of waste systems operation at these plants, further emphasize the diverse characteristics of these institutions and their respective waste systems.

The evaluation of these institutional waste systems was based on observations over a continuing period of several months. These observations were concluded with the preparation of a numerical rating on operational efficiency of the individual systems related to the environmental factors of sanitation, safety, security and esthetics. Detailed ratings of the individual hospital waste systems were previously presented in the respective chapters on each project (Table identification - "Numerical Rating of Hospital Solid Waste Systems"). In summary form, Tables IV-6, IV-7 and IV-8 were prepared to relate the more pertinent factors in these ratings. Table IV-6 shows the weighted deficiency rating of the total waste system operation as related to the four environmental factors.

TABLE IV-4 DAILY LABOR REQUIREMENTS FOR SYSTEMS OPERATION (Man-Minutes per Bed Patient)

System Component	LAC-USC Medical Center		Long Beach General Hospital		Harbor General Hospital		Rancho Los Amigos Hospital		John Wesley Hospital		Olive View Hospital		Mira Loma Hospital	
	Man-Min.	% of Total	Man-Min.	% of Total	Man-Min.	% of Total	Man-Min.	% of Total	Man-Min.	% of Total	Man-Min.	% of Total	Man-Min.	% of Total
Unit System	37	77.2	28	90.4	54	87.1	28	91.0	58	89.3	53	89.8	39	75.0
Inter-Unit System	7	14.4	-	-	4	6.5	1	3.0	4	6.1	2	3.4	11	21.2
Inter-Building System	2	4.2	3	9.6	2	3.2	2	6.0	3	4.6	4	6.8	2	3.8
Off-Site System	2	4.2	*0	0	2	3.2	TR	TR	*0	0	TR	TR	*0	0
TOTAL SYSTEM	48	100.0	31	100.0	62	100.0	31	100.0	65	100.0	59	100.0	52	100.0

*Contract Services

Comparisons of Hospital Solid Waste Systems

TABLE IV-5 ANNUAL, DAILY AND UNIT OPERATING COSTS

	LAC-USC Medical Center	Long Beach General Hospital	Harbor General Hospital	Rancho Los Amigos Hospital	John Wesley Hospital	Olive View Hospital	Mira Loma Hospital
QUANTITY OF WASTES PRODUCED:							
Disposables (Tons/Day)	11.60	0.55	4.53	2.77	0.68	2.19	0.37
Reusables (Tons/Day)	27.25	2.57	8.00	10.26	1.85	4.06	0.86
Total Waste (Tons/Day)	38.85	3.12	12.53	13.03	2.53	6.25	1.23
COST OF SYSTEM OPERATION:							
Annual	$2,396,850	$223,600	$777,435	$656,340	$296,582	$750,585	$175,200
Daily	$ 6,566	$ 612	$ 2,130	$ 1,798	$ 813	$ 2,056	$ 480
AVERAGE DAILY COST PER TON:							
Disposables	$ 305	$ 325	$ 327	$ 364	$ 664	$ 516	$ 551
Reusables	$ 110	$ 168	$ 82	$ 77	$ 195	$ 229	$ 322
Total Wastes	$ 170	$ 197	$ 170	$ 138	$ 321	$ 329	$ 390
AVERAGE DAILY COST/BED PATIENT:							
Disposables	$ 1.76	$ 0.58	$ 2.73	$ 1.09	$ 2.65	$ 2.02	$ 1.42
Reusables	$ 1.49	$ 1.44	$ 1.21	$ .85	$ 2.13	$ 1.65	$ 1.91
Total Wastes	$ 3.25	$ 2.02	$ 3.94	$ 1.94	$ 4.78	$ 3.67	$ 3.33

Comparison of Hospital Solid Waste Systems

TABLE IV-6 PERCENTAGE DEFICIENCIES IN ENVIRONMENTAL RATING OF SYSTEMS OPERATIONS

Environmental Factor	LAC-USC Medical Center	Long Beach General Hospital	Harbor General Hospital	Rancho Los Amigos Hospital	John Wesley Hospital	Olive View Hospital	Mira Loma Hospital
Sanitation	63	25	40	14	31	40	27
Safety	50	24	37	16	25	33	25
Security	59	24	27	19	18	34	32
Esthetics	57	28	42	26	26	35	35
Weighted Avg.	58	25	37	20	26	36	29

Table IV-7 expresses these ratings in percentage of deficiencies within sub-system or system components and functions within the components. Weighted average deficiencies as shown in Tables IV-6 and IV-7 are composite deficiency ratings calculated from the numerical rating Tables presented in Chapters II-VIII (Volume II). For example, in the case of the LAC-USC Medical Center, the percentage deficiencies of the environmental factors, as shown in Table IV-6, were calculated from Table II-18 (page II-53, Volume II) as follows:

Sanitation	1050/1675	=	63%
Safety	544/1080	=	50%
Security	546/925	=	59%
Esthetics	364/620	=	57%
Weighted Avg.	2504/4300	=	58%

The percentage deficiencies of sub-system functions as shown in Table IV-7 were calculated in a similar manner. For example, referring again to Table II-18 (Volume II), total deficiencies of the Unit system were calculated as follows:

Initial Deposit	217/415	=	52.3%
Initial Transfer	212/440	=	50.5%
Initial Storage, Proc.& Disposal	267/430	=	62.1%
Weighted Avg.	696/1265	=	55.0%

Table IV-8 illustrates the rated deficiencies in handling individual wastes at each hospital and also shows the relationship of individual waste quantities produced, as well as labor requirements of each within the systems.

By review of the descriptions of the solid waste systems (individual project reports), it is indicated that on-site handling of wastes is largely done by manual methods. The rating of on-site handling is therefore basically an assessment of the capabilities of labor in movement of the various types of wastes, the preparation of these materials and the conditions of storage facilities. These evaluations were based on prevailing practices observed at each facility during the observation period, and in accordance with the evaluation procedures outlined in the introductory section of this report. In close review of the numerical ratings of each hospital waste system, major deficiencies are found to generally prevail in storage functions, vertical transfer, inter-building transfer and off-site disposal, all of which are associated with the principal disposable wastes (sharps, rubbish, non-combustibles) as well as on-site handling of linen. Recommendations for upgrading these systems (Volume III) will consider these broad needs as well as specific deficiencies within the respective systems of each facility.

TABLE IV-7 PERCENTAGE DEFICIENCIES OF SUB-SYSTEM FUNCTIONS

Sub-System and Function	LAC-USC Medical Center	Long Beach General Hospital	Harbor General Hospital	Rancho Los Amigos Hospital	John Wesley Hospital	Olive View Hospital	Mira Loma Hospital
UNIT SYSTEM:							
Initial Deposit	52.3	38.1	50.8	20.7	31.8	47.0	37.3
Initial Transfer	50.5	27.6	47.6	6.2	27.9	35.0	20.5
Initial Storage	62.1	43.0	33.3	37.9	30.2	35.3	51.6
Weighted Average	55.0	36.0	44.0	22.0	30.0	39.0	37.0
INTER-UNIT SYSTEM:							
Vertical Transfer	41.2	-	38.8	-	36.6	-	-
Intermediate Storage	62.2	-	25.6	35.5	11.8	64.5	25.4
Weighted Average	52.0	-	32.0	19.0	24.0	34.0	13.0
INTER-BUILDING SYSTEM:							
Internal Transfer	54.9	19.4	37.7	16.3	24.6	27.1	22.3
Central Storage	74.8	39.4	54.8	8.3	35.1	13.2	39.3
Central Proc. or Disp.	67.4	.5	2.7	-0-	4.1	-0-	2.5
Weighted Average	68.0	19.0	31.0	8.0	21.0	13.0	21.0
OFF-SITE SYSTEM:							
External Transfer	23.3	11.3	14.9	6.2	6.2	16.0	10.5
Final Proc. or Disp.	71.8	45.1	45.1	35.6	34.9	69.5	49.2
Weighted Average	60.0	37.0	38.0	28.0	28.0	56.0	40.0
TOTAL SYSTEM	58.0	25.0	37.0	20.0	26.0	36.0	29.0

TABLE IV-8 RELATIONSHIP OF WASTE PRODUCTION, LABOR REQUIREMENTS AND SYSTEM DEFICIENCIES BY INDIVIDUAL WASTES

Type of Waste	LAC-USC Medical Center			Long Beach General Hospital			Harbor General Hospital			Rancho Los Amigos Hospital			John Wesley Hospital			Olive View Hospital			Mira Loma Hospital		
	% of Prod.	% of Labor	% Def.	% of Prod.	% of Labor	% Def.	% of Prod.	% of Labor	% Def.	% of Prod.	% of Labor	% Def.	% of Prod.	% of Labor	% Def.	% of Prod.	% of Labor	% Def.	% of Prod.	% of Labor	% Def.
Sharps, Needles, Etc.	.1	6.1	76	.1	1.7	44	.1	1.2	63	.2	3.0	16	.2	8.9	49	.2	1.1	53	.1	2.4	39
Path. & Surgical	1.3	.4	81	TR	.3	9	1.5	2.6	11	.1	.5	15	2.4	4.5	13	.3	.4	35	TR	.8	34
Soiled Linen	58.6	19.3	54	59.9	41.5	27	54.2	20.3	41	62.6	33.8	22	57.4	15.2	31	45.1	28.5	35	45.6	42.2	26
Rubbish	20.9	37.9	58	8.7	8.6	29	26.2	55.3	43	10.6	42.8	35	14.1	29.4	21	13.6	45.8	39	14.8	23.9	20
Reusable Patient Items	TR	5.2	8	TR	1.6	8	TR	1.0	8	TR	1.6	9	TR	2.2	42	TR	.7	16	TR	4.4	14
Non-Combustibles	1.8	6.2	50	1.2	2.2	29	2.0	3.4	42	2.9	2.3	22	2.6	7.7	31	2.2	.7	41	4.4	2.4	37
Garbage (Non-Grindable)	2.3	2.9	59	2.4	3.2	24	2.6	1.9	35	3.3	2.1	24	3.2	2.7	19	3.7	1.5	32	4.5	6.0	28
Food Service Items	11.6	20.2	38	22.4	30.4	8	9.6	12.4	23	16.1	11.8	10	15.8	27.8	13	20.0	17.3	7	24.4	14.3	18
*Radiological	TR	.1	-	-	-	-	TR	.5	-	TR	TR	-	-	-	-	TR	.1	-	-	-	-
Food Waste (Grindable)	3.4	1.7	-	5.3	10.5	-	3.8	1.4	-	4.2	2.1	-	4.2	1.6	-	14.9	3.9	-	6.2	3.6	-
TOTAL SYSTEM	100.0	100.0	58	100.0	100.0	25	100.0	100.0	37	100.0	100.0	20	100.0	100.0	26	100.0	100.0	36	100.0	100.0	29
Disposable Waste	29.8	55.3	69	17.7	26.5	28	36.2	66.3	41	21.3	52.8	22	26.8	54.8	29	34.9	53.5	42	30.0	39.1	33
Reusable Waste	70.2	44.7	37	82.3	73.5	17	63.8	33.7	27	78.7	47.2	15	73.2	45.2	19	65.1	46.5	23	70.0	60.9	21

*Not Included in Numerical Rating

SOLID WASTE SYSTEMS IN DETENTION FACILITIES

Investigations of solid waste systems in County detention facilities, as reported in Chapters VIII and IX (Volume II) and summarized herein, were conducted during the early months of 1969 to observe the physical characteristics of the plants and develop data on the solid waste systems. Institutions investigated included the Mira Loma Rehabilitation and Detention Facility, Central Jail, Sybil Brand Institute, San Fernando Valley Juvenile Hall and the Hall of Justice.

Considerable variations exist in function, size, population and types of inmates at these institutions. Table IV-9 provides a comparison of the varying physical characteristics of these institutions. Considerable variations were also found in the rate of waste production. However, types of wastes produced, and methods and practices employed in their respective solid waste systems, were very similar. Table IV-10 shows the comparison of total waste production by individual types of wastes and relates this production to building area and various population factors. By comparison with Table IV-2 (page IV-5), it will be noted, that as in hospitals, per capita unit production related to equivalent population shows a lessor variation in the range of production. It also suggests that for estimating and analysis of waste production quantities, this per capita factor may be more reliable and meaningful than use of other factors.

Functions of the Unit System are confined to individual cell block, dormitory and departmental activities generally performed by inmate occupants or work details. Observations of these in-plant housekeeping functions were of limited nature and not considered significant to this study. Detailed observations were generally confined to the Inter-Unit or Inter-Building and Off-Site systems.

The three basic categories of wastes found in these detention facilities (soiled linen, garbage and rubbish) are each handled in separate channels. Descriptions of the separate solid waste systems at each of these institutions, presented in Volume II and Appendix B herein, detail the system activities. Although the operation of these systems in detention facilities relies heavily on labor, it cannot be classified as the principal cost factor, as in conventional systems in other types of buildings. In fact, by comparison to other types of buildings, cost

Comparison of Detention Facility Solid Waste Systems

TABLE IV-9 DESCRIPTIVE CHARACTERISTICS OF DETENTION FACILITIES

	Mira Loma	Central Jail	Sybil Brand Institute	San Fernando Juvenile Hall	Hall of Justice
No. of Buildings	40	1	6	18	1
Range of Story Heights	1	2-6	2-4	1 & 2	12-14
Building Area (Sq. Ft.)	268,900	750,000	230,340	208,700	539,000
Inmate Capacity	533	3,000	836	515	2,900
Jail Personnel	158	500	166	233	217
Total Population(1)	691	3,500	1,002	748	3,117
Equivalent Population(2)	571	3,120	876	570	2,952
Ratio Inmates to Equiv. Pop.	93%	96%	95%	91%	98%
Type Inmate	Adult (M)	Adult (M)	Adult (F)	Juvenile (F & M)	Adult (M)

(1) Gross Population Includes all Employees and Inmates

(2) Equivalent Population Includes Average No. Employees and Inmates Present Each Shift 24 Hours/Day, 7 Days/Week

TABLE IV-10 BREAKDOWN OF DAILY WASTE PRODUCTION (LBS./DAY) BY TYPES OF WASTE

	Mira Loma	Central Jail	Sybil Brand Institute	San Fernando Juvenile Hall	Hall of Justice	Range Prod.(3)
REUSABLE WASTE:						
Soiled Linen	2,174	12,000	1,756	895	7,000	
DISPOSABLE WASTES:						
Rubbish	810	4,200	1,217	1,360	3,036	
Garbage	1,140	7,420	1,367	1,300	4,000	
TOTAL WASTES	4,124	23,620	4,340	3,555	14,036	
Lbs./MSF of Bldg. Area	15.3	31.5	18.8	17.0	26.0	106%
Lbs./Inmate	7.7	7.9	5.2	6.8	4.8	65%
Lbs./Person (1)	5.9	6.7	3.4	4.7	4.5	97%
Lbs./Capita (2)	7.2	7.6	4.9	6.3	4.8	58%
TOTAL DISPOSABLES	1,950	11,620	2,584	2,660	7,036	
Lbs./MSF of Bldg. Area	7.2	15.5	11.2	12.7	13.0	115%
Lbs./Inmate	3.6	3.9	3.1	5.1	2.4	113%
Lbs./Person (1)	2.8	3.3	1.6	3.5	2.3	119%
Lbs./Capita (2)	3.4	3.7	2.9	4.7	2.4	96%
TOTAL REUSABLES	2,174	12,000	1,756	895	7,000	
Lbs./MSF of Bldg. Area	8.1	16.0	7.6	4.3	13.0	272%
Lbs./Inmate	4.1	4.0	2.1	1.7	2.4	153%
Lbs./Person (1)	3.1	3.4	1.8	1.2	2.2	183%
Lbs./Capita (2)	3.8	3.9	2.0	1.6	2.4	144%

(1) Based on Gross Population Including Total Inmates and Employees
(2) Equivalent Population is Average Shift Population Present 24 Hours per Day, 7 Days per Week
(3) Range in Production Over Lowest Production Factor

elements of detention facility systems are insignificant. Table IV-11 was prepared to illustrate identifiable cost elements in the respective systems. In general, these consist of contract services providing storage bins, collection, hauling and off-site disposal at landfills. With the exception of the Hall of Justice where the County Department of Building Services assists in the Inter-Unit system, no other labor costs are acknowledged. Relating total identifiable costs to waste quantities indicates a modest range of about $0.01 to $0.02 per pound is incurred in the operation of the waste systems.

The evaluations of these detention facility waste systems were based on observations over a continuing period of several weeks. These observations were concluded with the preparation of a numerical rating on operational efficiency of the individual systems related to the environmental factors of sanitation, safety, security and esthetics. Detailed ratings of these systems are presented in Volume II and Appendix C herein. Summaries of these ratings have been prepared showing percentage deficiencies within the systems operation, as illustrated in Tables IV-12 and IV-13.

Table IV-12 expresses these ratings in percentage deficiencies within the system components and functions and shows the weighted deficiency rating related to the four environmental factors. Table IV-13 illustrates the rated deficiencies in handling individual wastes at each institution and the significance of quantities of each material.

These ratings, as in the case of hospital system ratings, were largely an assessment of the capabilities of labor in the movement of waste materials, the preparation of these materials and conditions of storage facilities. These evaluations were based on prevailing practices observed at each facility during the observation period in accordance with evaluation procedures outlined in the introductory section of this report. Review of the ratings indicate principal deficiencies generally prevail in central storage and off-site disposal associated with the rubbish system.

Comparison of Detention Facility Solid Waste Systems

TABLE IV-11 CONTRACT SERVICES FOR COUNTY DETENTION FACILITIES

	Mira Loma	Central Jail	Sybil Brand Institute	*San Fernando Juvenile Hall	Hall of Justice
CONTAINERS FURNISHED:					
No.	13	10	5	-	12
Type	Comm. Bins	Comm. Bins	Comm. Bins	-	Comm. Bins
Size	3 CY	4 CY	3 CY	-	3 CY
COST OF SERVICES:					
Monthly	$351.00	$342.00	$150.00	-	$336.00
Daily	$ 11.70	$ 11.40	$ 5.00	-	$ 11.25
Type of Wastes Received	Gar. & Rub.	Rubbish	Gar. & Rub.	-	Rubbish
Tons of Waste Per Day	1.0	2.1	1.3	-	1.5
Cost per Cubic Yard	$ 0.30	$ 0.29	$ 0.33	-	$ 0.31
Cost per Ton	$ 11.70	$ 5.45	$ 3.75	-	$ 7.50

Note: Contract Services Include Furnishing Bins, Collection 6 Days/Week and Disposal by Landfill

*San Fernando Juvenile Hall - Open Storage of Rubbish on Loading Dock is Collected by Olive View Hospital Packer Truck

Comparison of Detention Facility Solid Waste Systems

TABLE IV-12 PERCENTAGE DEFICIENCIES IN SYSTEMS OPERATIONS

Sub-System and Functions	Mira Loma	Central Jail	Sybil Brand Institute	San Fernando Juvenile Hall	Hall of Justice
INTER-UNIT OR BUILDING SYSTEM:					
Internal Transfer	32	29	25	22	29
Central Storage	61	31	44	49	70
Central Processing or Disposal	8	-	8	-	-
Total	36	20	26	24	34
OFF-SITE SYSTEM:					
Internal Transfer	7	21	9	24	21
Final Processing and/or Disposal	40	47	32	47	54
Total	26	36	22	37	40
TOTAL SYSTEM	32	27	24	30	37
ENVIRONMENTAL FACTOR RATING:					
Sanitation	16	25	15	22	28
Safety	27	21	20	25	27
Security	41	30	30	29	45
Esthetics	40	32	30	41	45

TABLE IV-13 RELATIONSHIP OF WASTE PRODUCTION AND SYSTEM DEFICIENCIES

Type of Waste	Mira Loma		Central Jail		Sybil Brand Institute		San Fernando Juvenile Hall		Hall of Justice	
	% of Prod.	% Def.	% of Prod.	% Def.	% of Prod.	% Def.	% of Prod.	% Def.	% of Prod.	% Def.
REUSABLE WASTE:										
Soiled Linen	52.7	14.0	50.8	26.0	40.5	14.0	25.2	24.0	49.9	31.0
DISPOSABLE WASTES:										
Rubbish	19.6	47.0	17.7	34.0	28.0	36.0	38.3	42.0	21.6	43.0
Garbage	27.7	33.0	31.5	21.0	31.5	22.0	36.5	24.0	28.5	37.0
TOTAL WASTES	100.0	32.0	100.0	27.0	100.0	24.0	100.0	30.0	100.0	37.0

SOLID WASTE SYSTEMS IN COUNTY OFFICE BUILDINGS

Investigations of the solid waste systems in County office buildings, as reported in detail in Chapter X (Volume II), were conducted during December, 1968, and early months of 1969 to observe the physical characteristics of these buildings and develop data on the solid waste systems. Buildings investigated included the Hall of Records, Hall of Administration, County Courthouse and the County Engineers Building.

It may be summarized that these buildings, though varying in both function and size, are similar insofar as solid waste management is concerned, with the County Department of Building Services handling this function at each building. Similarity of in-building handling and storage methods prevails, as well as the similarity and range of contract services received at each facility. The descriptions of office building solid waste systems, presented in Volume II and Appendix D herein, detail these activities. Tables IV-14 and IV-15 were prepared to illustrate other comparisons made of the waste systems operation.

Table IV-14 shows certain building characteristics, as well as average daily waste production and estimated operating costs of the systems calculated during the observation period. Production related to building areas shows an overall average of 2.8 pounds per MSF (thousand square feet) of building area is experienced in these buildings, with the County Engineers Building showing a substantially higher production at 4.9 lbs./MSF. This higher rate was due to a large volume of blueprints being handled, which is not uncommon at this building. Costs of operation of these systems can be related to an average cost per ton at about $350, in a range of costs from $312 to $504 per ton. As in hospitals, labor was found to be the most significant cost factor in systems operation. Distribution of system costs reflects an average of about 88% in labor, 3% in contract services and 9% in building, equipment and accessories. Distribution of these costs to the system components shows an average of 83% expended in floor activities (the Unit system), 14% in between-floor handling (the Inter-Unit system), and 3% in the off-site system.

The evaluations of these office building waste systems were based on observations over a continuing period of several weeks. These observations were concluded with the preparation of a numerical rating on operational efficiency or deficiency of the individual systems related to the environmental factors of

Comparison of Office Building Solid Waste Systems

TABLE IV-14 WASTE PRODUCTION AND COSTS OF OPERATION

	Hall of Records	Hall of Administration	County Courthouse	County Engineers
Building Area (Sq. Ft.)	404,000	1,000,000	660,000	171,000
No. of Floors	17	10	9	11
Daily Waste Production (Lbs.)	1,000	2,560	1,750	840
Daily Production (Lbs./MSF of Bldg. Area)	2.5	2.6	2.6	4.9
Annual Operating Costs	$ 65,385	$ 103,708	$70,617	$42,717
Avg. Daily Costs	$ 252	$ 399	$ 273	165
Cost per Ton	$ 504	$ 312	$ 312	$ 393
Cost per Lb.	$ 0.25	$ 0.16	$ 0.16	$ 0.20
Distribution of Costs				
Building & Equip.	7.9%	10.1%	8.6%	9.2%
Contract Services	2.2%	3.5%	2.4%	2.5%
Labor	89.9%	86.4%	89.0%	88.3%
Total	100.0%	100.0%	100.0%	100.0%
Distribution of Costs				
Unit System	82.2%	84.0%	82.0%	89.4%
Inter-Unit System	15.6%	12.5%	15.6%	8.1%
Off-Site System	2.2%	3.5%	2.4%	2.5%
Total	100.0%	100.0%	100.0%	100.0%

sanitation, safety, security and esthetics. Detailed ratings of these systems are presented in Volume II and Appendix E herein. Summaries of these ratings have been prepared showing percentage deficiencies in the systems components and functions and the weighted deficiency rating related to the four environmental factors, as illustrated in Table IV-15.

These ratings, as in the case of hospital system ratings, were largely an assessment of the capabilities of labor in the movement of waste materials, the preparation of these materials and conditions of storage facilities. These evaluations were based on prevailing practices observed at each facility during the observation period, in accordance with evaluation procedures outlined in the introductory section of this report.

Due to the uniform and relatively inoffensive nature of the waste materials handled, as well as the advantages of a single waste channel handling all waste materials, complexity in these waste systems is minimized. Satisfactory operation is limited only by the capability of plant facilities provided and accessory equipment used, as well as the skill and inclination of labor. By and large, labor performs effectively within these systems using very simple equipment. Custodial crews in office buildings, as opposed to hospitals, have the added advantage of working in unoccupied buildings in off-peak hours where productivity and supervision of labor can be satisfactorily controlled. The most significant deficiencies in these systems are in the functions of central storage and off-site disposal. Due to the nature of waste materials, system sanitation does not pose the severe problem as found in hospitals; however, conditions affecting safety, security and esthetics are of major significance.

Comparison of Office Building Solid Waste Systems

TABLE IV-15 PERCENTAGE DEFICIENCIES IN SYSTEMS OPERATIONS

	Hall of Records	Hall of Administration	County Courthouse	County Engineers
UNIT SYSTEM:				
Initial Deposit (Receiver)	22	22	22	22
Initial Transfer	17	17	17	17
Initial Stor., Proc., Disposal	38	38	47	25
Total	28	28	32	22
INTER-UNIT SYSTEM:				
Internal Transfer	22	37	35	22
Central Storage	31	71	40	93
Central Processing or Disposal	-	-	-	-
Total	21	43	29	47
OFF-SITE SYSTEM:				
External Transfer	17	17	27	17
Final Processing or Disposal	71	71	71	71
Total	55	55	58	55
TOTAL SYSTEM	31	41	37	42
ENVIRONMENTAL FACTOR RATING:				
Sanitation	20	20	20	20
Safety	27	39	38	47
Security	36	63	43	51
Esthetics	43	43	48	48

SUMMARY

In the course of this study, certain pioneering has been undertaken in the identification of building waste systems, adoption of nomenclature of sub-systems and functions within these systems, and development of methods of evaluation of waste system operation. These tasks were fundamental to the total study and were carried out to the stage of development which appeared adequate for the continuing phases of the study to progress. Hopefully, these preliminary efforts to develop standard terminology may be refined for practical application in the industry as may later be required. However, for purposes of this study, application of these basic principles have aided in the determination of requirements of the solid waste systems, provided the yardstick for measuring the efficiency or deficiency of systems operation, and provided a means of conveying these findings to the reader.

These findings have emphasized the prevailing problems of solid waste management and systems operation common in those local projects investigated, as well as common in other public and private facilities observed in other areas of the country.

Prevailing Problems in Solid Waste Management in Buildings:

Probably the most important problem within solid waste management in complex buildings is lack of knowledge or awareness of an identifiable and indispensable system, what it costs to operate and a method of measuring its effectiveness. In most cases, there is an established policy on handling waste materials but in practice the actual operation of the waste system rarely corresponds to that policy.

Until recently, the total solid waste system as such within buildings has been ignored and is not yet commonly recognized or even easily identifiable. Little research has been carried out to explore the in-building problems associated with solid wastes. These waste materials have been looked upon as a by-product of our activities, of little significance, just something to "get-rid-of", with little real concern how that may be accomplished; when, in fact in a way, waste is the end material product of our activities. This can best be comprehended when we realize the simple fact that sooner or later nearly all material products are converted to waste. In the case of consumable supplies, our principal daily source of wastes, this conversion is represented by a constant daily flow of waste materials. With this in mind, the basic concept of solid waste for this study was based on the principle that the majority of materials entering an institutional building and distributed for use are converted to wastes in a continuing flow, with all solid wastes cycled out in a reverse pattern from distribution of new supplies. This concept also applies to those reusable items that may be cycled out after use for either on-site or off-site reprocessing.

Certain variations of this concept occur, dependent on the building type and functions, such as hospitals where certain biological wastes may be generated within the institution, and office buildings where many of the supplies when processed are dispatched to an ultimate off-site receiver.

Recent emphasis on the environmental effect of solid wastes, both in-plant and to the community at large, has brought to the surface many problems heretofore ignored or unrecognized. Progress in building design, accompanied by the increase of multistory complexes and higher density of land use, as well as increasing per capita rates of waste production, have tended to create large concentrations of solid wastes at limited accumulation points in building service areas where access for removal is limited. These conditions have further emphasized the material handling problems associated with the in-building movement of solid waste materials, on-site storage and disposal or off-site transfer for disposal.

Causes of Problems:

Prior to the current era of growing awareness of the solid waste problem in buildings, design consideration for handling waste materials has, at best, largely been limited to the location of conventional waste chutes and storage rooms, even in the more sophisticated building designs, primarily because this was the only equipment and method available. Consequently, the problems that exist in these buildings today are inherent to design.

It can be recognized that manually working a conventional solid waste system may be a distasteful and dirty job. This will be a certainty without direct policies and standards of operation coupled with conscientious working supervisors and trained crew members to produce the desired standards.

Reasonable standards of operation can be expected where building maintenance activities can be performed in off-peak hours or when buildings are vacant, such as the services prevailing in office buildings. By contrast, performance of these activities in hospitals coincides with peak activities of other functions during the first shift operation. Depending on the complexities of plant layout and traffic congestion, close surveillance and supervision of operation of the solid waste system within reasonable economic limits is unlikely, and reasonable standards of operation are difficult to maintain consistently. This substandard operation, though directly the failure of labor to perform a satisfactory job, can be traced further to the inadequacies of system design to meet present day requirements.

Required Development of Remedial Measures:

Generally, the standards of performance of manual tasks in connection with collection and storage of wastes in the Unit System are at present totally dependent on policies and housekeeping practices and are not likely to be remedied through mechanization. However, within present day technology, it would appear that substantial mechanization of the balance of the system is feasible and that solutions to the more critical problems will ultimately be in the design of buildings. A coordinated and massive attack by architects and engineers, coupled with firm operating and administrative policy of building management, may well be what it takes to stimulate these solutions.

These solutions, through design, may be accelerated through recognition of the overall effect of operation of inadequate systems, both from environmental and economic aspects.

Further tightening of codes and regulations that recognize and control environmental problems of the community and building occupants can be expected when the effects of solid waste system operation are positively related to existing environmental hazards.

The investor (developer, owner or operator) must be made aware of the economic benefits that may result from the mechanized system. Cost studies of mechanized systems will, of course, reveal that initial capital investment requirements will far exceed the cost of conventional systems. However, development of complete cost data showing comparisons of total annual costs (capital and operating expenses) and the economic feasibility of the mechanized system opposed to the conventional system may provide the investment incentive to expand the construction budget.

The solid waste system must be popularly recognized as a requisite mechanical equipment component in building design and given early consideration in the preliminary design stages (the same consideration given to plumbing, air conditioning, heating, ventilating, etc.) in order to integrate another vital function in an orderly manner. With complex building layouts providing high density occupancy and correspondingly, high rates of waste production, periodic consultations with specialists in the fields of industrial engineering, materials handling engineering and solid waste management may be desirable and beneficial from the preliminary design stage throughout the design process. Design consideration should also be given to multiple purpose material handling systems to handle both new supplies and waste materials.

In short, the problems must be solved in the same manner as industry mechanized production lines several decades ago.

It is vital that design standards be developed for solid waste systems in various types of buildings. These standards should be adequate not only for present levels of waste production but must also consider present trends affecting increases in rates of waste production for certain types of buildings.

System design must provide flexibility for modification and expansion to meet potentially large increases in waste production which are likely to result from the adoption of single-use disposables, as well as the natural increase of wastes being experienced annually. As indicated in the hospital studies, conversion from reusable to disposable linen may increase the loadings of disposable wastes from 100% to 200% on the relatively short notice of an administrative decision. This increase in most cases would not affect the in-building handling materially; however, would likely overburden storage and/or disposal facilities.

With critical solid waste problems, such as these, facing architects and engineers, as well as developers and building management, needed acceleration of solutions in the design of systems for both buildings in the design stage and existing buildings is obvious. However, no single source of information offering concise data on total systems or equipment that is presently marketed is available as a guide to determining interim solutions.

Continuing Studies:

In the course of this continuing study, a review of recognized publications providing coverage on various aspects of solid waste management, as well as direct contact with manufacturers, was undertaken in an effort to assemble a cross section of the equipment that is readily available for consideration in the design of building systems. This information is incorporated in Volume III (and summarized in Chapter V of this volume), which defines and catalogs equipment components and accessories by functions within the system, i.e. handling, storage, processing and disposal. This volume also covers selected equipment in developing and experimental stages that may prove to be adaptable to building systems at some future date.

This equipment research, together with the inventory and evaluation of existing solid waste systems in the local projects as summarized herein, provides the necessary background for the continuing study on upgrading of these systems, which is presented in its entirety in Volume IV and summarized in Chapter VI of this volume.

In conclusion of this study, design requirements for solid waste system improvements in a selected local project, including preliminary plans, outline specifications, construction costs and benefits of the system are developed.

This series of studies demonstrates the need for greater emphasis on solid waste management in buildings, the state-of-the-art in equipment development and development of design criteria, as well as the potential of economic and environmental benefits that may result from an adequate system design.

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LIST OF FIGURES

An integral and vital division of this study has been the research and investigation of equipment in the developmental stage and currently available for use in solid waste systems in buildings. This investigation was concluded with the compilation of a report incorporating descriptions and illustrations of the individual equipment components. Obviously, due to the nature of this type report, a meaningful summary is not feasible and the reader is referred to the complete volume (Volume III) for specific data on the various types of equipment cataloged. To apprise the reader of the arrangement of material in this volume, the following sections describe the contents and generally summarize observations made during the course of this study.

Organization of Material:

In the early stages of this investigation, it was anticipated that classifications and definitions of the various types of equipment encountered were requisite to the study both for the readers' benefit and as a working tool in preparation of the report. The major classifications or divisions of equipment were limited to correspond to the four basic functions of the waste system, i.e. handling, storage, processing and disposal.

The sections of Volume III devoted to the narrative review of this equipment also follow these classifications. In the review of equipment, every effort was made to describe representative makes of equipment and such descriptions are included for general informational purposes only. In support of this equipment review within each major classification, referenced appendices were prepared, identifying (sub-classification) by name and definition, the individual equipment components and accessories. Separate appendices (Product Lists) were also prepared, listing these equipment components alphabetically and identifying respective manufacturers and known trade names. To complete the appendices in Volume III in support of this equipment review, a master alphabetical index of these manufacturers was prepared.

The listing of manufacturers of various products as identified in Volume III is only partial. To identify every manufacturer producing equipment related to the subject appeared neither practicable considering the time limitations imposed, nor necessarily useful for purposes of this report. There are many lists published covering specific types of equipment, such as those to be found in Material Handling

Engineering Handbook & Directory; Solid Wastes Management Sanitation Industry Yearbook; Guide Issue, Journal of the American Hospital Association, as well as many other sources. In general, product listings were restricted to those items which were seen at trade shows, inspected in operation, or on which descriptive printed matter was reviewed. Numerous equipment manufacturers failed to respond to inquiries and hence are not included.

During the course of this investigation, voluminous project records, consisting of equipment catalog files, inspection reports and correspondence with numerous manufacturers, were developed. The written review as presented in Volume III in a sense represents only a summary of the total activities undertaken.

HANDLING METHODS

The major task and cost in the operation of solid waste systems is the movement of waste material between the initial point of accumulation and the ultimate disposal point. In effect, operation of solid waste systems is largely a material handling function, adaptable to mechanization but predominantly performed today by manual methods. Today's manual systems are largely "built-in" by building design conditions. It is not uncommon to find, even in contemporary designs, numerous interim waste storage points for the temporary deposit of wastes, thereby breaking the cycle of movement and thus creating a number of rehandlings of the same material before reaching the final destination point. Today, scarcity of labor for this type of work, the trend of lower productivity of labor, as well as rising labor rates, collectively emphasize the need for mechanization of the more complex systems.

Unfortunately, far too much of the solid wastes, as well as supplies in institutions, are "handled" and "rehandled" instead of being directly transported by mechanical means. These conditions have been permitted to develop by institutional and industrial planners and management. Institutional management, habitually satisfied to "do it by hand", ignored the development of these plant engineering needs, planners were not aware of these needs, and the materials handling industry was not properly alert to a new market. The latter was apparent during the course of this investigation when it was found that many equipment manufacturers were unaware of the needs in the field of solid waste handling at the time they were first contacted. Due to this, it was equally apparent early in the investigation that developing information on waste handling methods and equipment would be more time-consuming and involved than would be that required for storage, processing and disposal methods. Considerable time and effort was made in contacting manufacturers and as a result of many otherwise unproductive inquiries, it is indicated that some companies have been prompted to investigate the material handling problems in solid wastes. Hopefully, new contributions in useable equipment will be forthcoming for this field.

The apparent reluctance on the part of some manufacturers to become involved in waste handling is somewhat understandable. In general, the subject of materials handling has long been almost solely associated with industry. Applications of their methods and equipment in the past have been primarily directed to warehousing, processing and manufacturing industries, where identical, or at least similar, articles are handled. If the material is in bulk, it normally has consistency in shape and other physical characteristics throughout its volume and, hence, mechanical handling is not too difficult to develop. On the other hand, solid wastes, especially those generated in hospitals, almost defy description. This material lacks uniformity of size and shape. It is a non-homogeneous mix and may be highly contaminated. Adapting a mechanical handling system to these conditions may be highly complex.

The relationship of the movement of "clean" and "dirty" materials within a building complex is an involved process. In effort to simplify the relationship of this process, Figure V-1 schematically shows the supply-waste cycle. This diagram is admittedly an oversimplification but serves to emphasize the parallel course in movement of supplies and wastes and the basic activities between the point of supply, point of use (or conversion to waste), and ultimate point of disposal. Locations of these activities (storage and processing) for both supplies and wastes may be and generally are interspersed throughout the system. The point is that planned material handling systems can minimize the interim storage needs and permit efficient direct and uninterrupted flow of both materials.

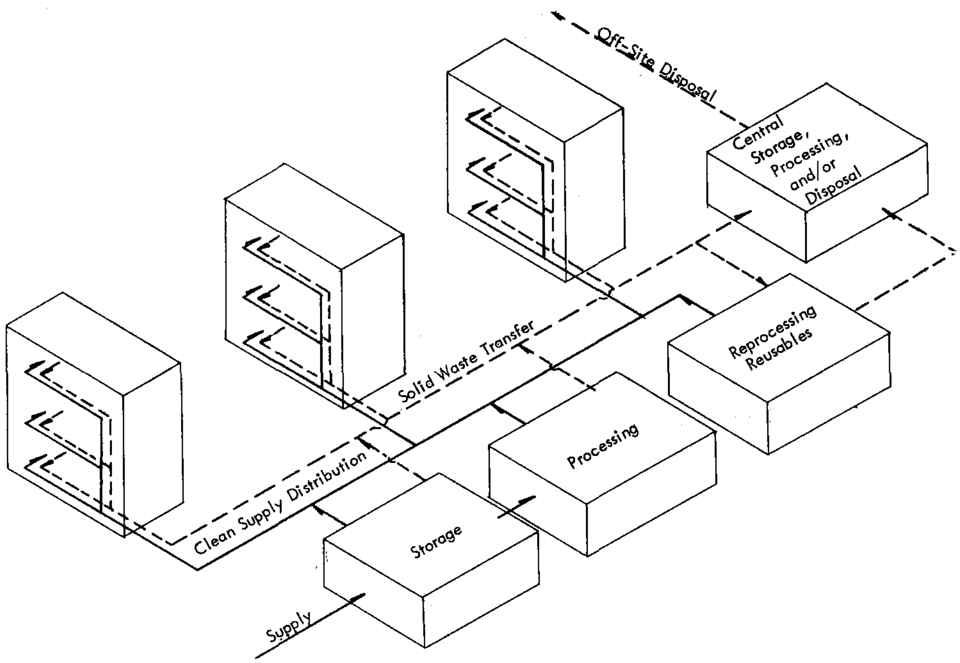


FIGURE V-1
SUPPLY-WASTE CYCLE IN A TYPICAL MULTISTORY BUILDING COMPLEX

It is essential that the reader be made aware of the current state-of-the-art as it applies to solid waste handling. Considering the existing need, it is inadequate. While some advancement is being made, these efforts range from meager to sophisticated. However, if one thinks of general materials handling, as opposed to the handling of solid wastes, then giant strides have been made. Electronically controlled, fully automated supply systems are available, but they are neither presently suitable for specialized use in handling solid wastes nor economically feasible for this purpose alone. Types of equipment, such as overhead chain conveyors, horizontal or inclined belt conveyors, or perhaps long roller conveyors as used in industry, do not at first glance seem to be applicable to the problems encountered in solid waste handling. Although perhaps not directly useable, it is possible that these basic methods of moving materials might be modified to meet the needs under study.

With few exceptions, little has been seen which could be described as complete solid waste handling systems. There are hundreds of different pieces of equipment designed and produced to handle or transport material items. These individually are considered in this report as equipment components and not systems. Most of the installations seen have consisted of a number of components rather than a complete integrated system.

The most elementary and, at the present time, the most widely used class of horizontal transport devices in use for the horizontal transport of solid wastes in institutions is the hand-pushed cart. This indispensable piece of equipment comes in many shapes and styles; is available in metal, fiber and plastic; and of standard or special designs. Carts are available from simple open-top canvas hampers to specially designed stainless steel bodies. A very wide range of types of conveyors, including roller, belt, chain, monorail and pneumatic tube, plus many varieties of these principal classifications, may also be considered in the general class of horizontal transport equipment. For off-site operations and for some possible on-site transport requirements, special types of collection vehicles or mobile packers or transfer trailers may be employed.

Gravity and vacuum chutes alone are the only equipment items specifically designed and commonly used for the vertical transport of wastes. The principal forms of multipurpose vertical transport are elevators, dumbwaiters or specially designed lift systems, which will accommodate only carriers or transporters of a special type and handle all types of material. Controls may be manual, i.e. they can be summoned or dispatched by push buttons or they may be automated to sequence with loading from or unloading to horizontal conveyors.

Some devices, such as pneumatic tubes, gravity chutes, certain types of conveyors, and other equipment, provide multiple functions. They not only transport materials but may be used to load or discharge bulk or containerized items, and may incorporate interim storage or holding stations for en route materials. These may be complete horizontal and vertical transport systems designed and installed by one manufacturer or they may be combinations of loading devices, horizontal and vertical conveyors and discharging equipment of different manufacture, which have been combined into an integrated system.

Such devices as blowers or suction fans, cyclonic separators, pneumatic tubes, various types of conveyors, vertical lifts, pipelines for slurries, and other equipment can be arranged to operate as an integrated handling system. Some of the most interesting general materials handling systems observed have been examples of good engineering and the apparent successful "marriage" of components made by different manufacturers.

The most sophisticated, fully automated systems were designed and largely built and installed by single manufacturers. These combine horizontal and vertical transport elements, using special track, transporters, modules and electronic controls. Units can be summoned and dispatched from control panels and operated within the system, unattended.

The review of handling equipment as contained in Volume III covers the limited field of specialized equipment for handling solid wastes as well as certain general materials handling equipment and accessories considered to be adaptable for possible use in solid waste systems.

STORAGE METHODS

Storage of wastes for purposes of this report has been previously defined as the interim containment of accumulated materials in either loose, compacted or other processed form prior to subsequent handling, processing or disposal.

Storage as related to solid wastes further includes required facilities for the containment of both reusable materials (such as soiled linens) and disposable wastes. However, this section of the study is primarily concerned with the problems associated with disposables. Characteristics of these materials subject to storage may range from loose, mixed or segregated wastes (including rubbish, food wastes, sharps, pathological, and non-combustible materials) to various types of processed wastes (including shredded, baled, compacted and pulped materials).

Containment of loose wastes may be accomplished with various types of accessories for dry storage, such as bags, wastebaskets, barrels, bins, etc. in either its bulk state as collected or after undergoing certain dry processes such as shredding, pulverizing, which achieve a substantial degree in volume reduction and produce a homogeneous end-product.

Other methods of volume reduction may be accomplished with various types of compaction devices, such as packers and balers. These dry compaction processes may handle both loose bulk wastes or shredded or pulverized wastes. Conventional containment of these materials is by compaction in special bins, containers and in some cases standard cans and paper bags. In the case of some balers, the compacted wastes are merely strapped for open storage.

Certain reduction processes involving both grinding or shredding and compression, together with the addition of a small amount of moisture, produce a moist homogeneous compacted waste in an extruded form. Storage accessories for this end-product are similar to those for loose wastes, although the volume requirements are considerably reduced.

The pulping process, in which loose or bagged dry wastes are greatly reduced in particle size by grinding and shearing action in the presence of water, produces a slurried wet waste. The liquid slurry can either be transported through pipelines for further treatment or passed through a dewatering press. In the latter case, the end-product is a damp, uncompressed sludge of high moisture content and high density. Storage requirements may be limited to barrels or special containers where larger volumes are involved.

Storage and handling are inextricably related. The wastebasket, the simplest form of a storage unit, must be emptied, usually into a larger receptacle, which, in turn, is another storage unit. The emptying process and the movement of both the waste-basket and the larger receptacle are elements of the handling process. The large waste receptacle is moved, usually on a manually pushed cart to a terminal point on the floor. If, when the cart reaches this destination, the accumulated and presumably bagged waste was deposited in a chute or other handling device, no further interim storage space need have been provided on the floor for waste accumulations. What is perhaps more important, one entire handling operation would have been eliminated.

The foregoing is not against the provision of necessary storage areas. It is in favor of reducing the tendency in institutions to use storage areas for the avoidance of work by some and creating work by leaving items for others to rehandle. It favors the elimination of any unrequired operations, especially the most expensive of all, manual tasks. Storage areas are highly essential but they should be planned in conjunction with the actual requirements of the handling system, for both functions are inseparable.

Waste storage facilities must include the various types of temporary storage receptacles, such as bags, baskets, barrels, packer containers and bins, etc., but also the properly planned storage areas, rooms or spaces in which the equipment will be used and handled. These areas must be carefully located within individual rooms, departments, utility stations and on the ground floor or basement service levels as well. If stationary packers are to be used, ample horizontal and vertical clearance must be provided to permit the movement of loading equipment. Provision must be made for adequate cleaning and sterilizing of the waste storage areas, as well as equipment and receptacles.

It is recognized that despite the need for the reduction of the numbers of storage points, adequate spaces must be provided within the Unit, Inter-Unit and Inter-

Building systems. No amount of desire will eliminate the necessity for properly planned, well laid out and adequately sized storage areas within the total solid waste system.

In planning storage areas, the volumes and compositions of the generated wastes must be known or estimated with reasonable accuracy. The total handling concept must be determined as well as methods of processing and disposal before the number, sizes and locations of the storage areas and the required equipment can be determined.

The review of storage equipment as contained in Volume III covers the limited specialized components available for the storage of wastes, as well as numerous accessories employed for this function.

PROCESSING METHODS

During the course of this study, it became increasingly evident that some form of preparation of solid wastes prior to planned disposal is desirable, and under certain conditions is essential. Present practices in disposal operations will not suffice for the changing composition of solid wastes. The need for some preparation of general solid wastes prior to attempted disposal by sanitary landfill or other methods deserves extensive and continuing investigation. Such processes as grinding or shredding permit more material to occupy a given space than is the case with present methods of disposal of raw untreated wastes. In addition, the decomposition of waste materials is hastened by particle size reduction.

Dry grinding of solid wastes prior to incineration or deposit in landfills deserves consideration but alternative methods of disposal should be studied. Reduction by wet grinding or pulping and the creation of a readily transportable slurry constitutes another method which deserves in-depth investigation. A variation of this method involves dewatering of the pulped wastes into a moist sludge for easier handling with less bulk. Although these methods may be considered as means of disposal by the user, they are only processes or preparation of the material for subsequent handling and ultimate disposal.

Processing, as related to this study, includes some operations which are highly interrelated with handling, storage and disposal functions. The criteria used for identification of processing functions is based upon physical change of the loose raw materials. Waste processing is considered as those preparation functions, such as bagging or encapsulating of disposables and reusables, as well as treatments to disposables involving volume reduction through changes in size and shape, uniformity or consistency. The degree of volume reduction and corresponding increase in density varies with the method or combination of methods employed and the composition of the material input. Typical processes or combinations of these processes which precede ultimate disposal may include:

Bagging	Shredding	Pulverizing
Encapsulating	Chipping	Dewatering
Compaction	Grinding	Baling
Crushing	Pulping	Extrusion

Probably the simplest form of processing of solid wastes is packaging. This includes the manual separation of certain wastes and depositing the material in bags or special containers for interim storage until the container is injected into some type of handling system. By bagging, packaging or other encapsulating processes, conditions of the wastes have been changed from loose to contained for greater ease in handling, as well as improvement in sanitation.

Methods or devices which reduce the bulk of solid wastes by compression include such items as balers, crushers and packers. Drastic changes in size, shape and consistency by homogenizing mixed waste materials is another variation in reduction processes employed to facilitate handling, further processing or ultimate disposal. Such equipment as grinders, shredders, pulverizers, and pulpers may accomplish this initial reduction. Further positive reduction may be accomplished by such devices as pelletizers and extruders or dewatering presses in the case of pulped wastes.

Various combinations of equipment components for processing solid wastes are being researched by manufacturers in efforts to develop satisfactory processing or disposal systems. One such combination of components is a pulper having a dewatering press and junk remover as connected processes for reduction of solid waste to a moist sludge form for subsequent disposal in landfills or incineration. Another manufacturer combines a grinder of the hammermill type with an extruding device which reduces solid wastes to highly compressed, moist briquettes. Still another processing system is one which combines a blow hog and a cyclone to combine pneumatic transport of raw and treated materials with a reduction process. The end product is a finely shredded, dry material prepared for incineration or other means of disposal.

The review of processing equipment as contained in Volume III covers the broad field of specialized equipment and accessories for processing solid wastes as well as certain equipment used in industrial processes that may be adaptable to use in waste processing systems.

FINAL PROCESSING AND DISPOSAL METHODS

Singularly, the most emphasized need and least developed function or activity in solid waste management is that of disposal. Conversely, however, the greatest investment and advances in equipment for solid waste systems occur in handling, storage and processing functions preceding disposal. Development of satisfactory disposal processes, free of pollution effects on the environment, has been lagging and processes are still being researched.

Disposal is considered herein as the final treatment or combination of treatments in the conversion of wastes to innocuous materials or useable by-products. By and large, known disposal methods are limited to relatively few conversion processes, some involving conversion by normal decomposition of materials and several processes which involve accelerated conversion.

Conversion of waste materials may be accelerated by destructive disposal processes, such as controlled incineration and supervised or unsupervised open burning. These processes produce high volume reduction of solids with the end product of these processes being a mixed residue including ash and non-combustible materials of high density, as well as gaseous air pollutants. Conversion may also be accomplished by natural composting or accelerated by means of various mechanized systems. Products of these mechanized composting systems are a sterile organic soil and gaseous air pollutants. The composting process in itself does not greatly reduce the volume of waste materials. However, substantial reduction in the end product may be accomplished in conjunction with those reclamation activities normal with composting processes and where high ratios of salvageable materials are present. Grinding of food wastes for discharge to sewers with ultimate processing at treatment plants and final deposit of sludge at sanitary landfills or use as soil conditioner is popularly accepted in many areas as the best method of disposal of garbage. In addition, other terminal processes such as wet air oxidation, which may produce a sterile slurry or ash cake, and pyrolysis, a destructive distillation process producing sterile charred solids, are among the numerous newer conversion processes being explored for development.

Salvage of selected waste materials in the past has had great significance and currently this reclamation concept is regaining popularity, although economics are not always favorable. Among the materials of greater significance for salvage are paper, rags, ferrous and non-ferrous metals, glass and rubber. Other salvage processes such as rendering of animal carcasses and fats for production of fertilizer, glue, soaps, etc., as well as salvage of food wastes for swine feeding, still prevails in many areas of the country. Both methods generally require segregation of the wastes at the source of generation and often require refrigerated storage. Excessive handling costs in nearly all reclamation processes are the overriding factors in the economic feasibility of disposal by various reclamation processes.

Disposal by sanitary landfill, open dumping and dumping at sea are the only processes where conversion is not accelerated by man and where normal decomposition of the organic material occurs. However, dumping of solid wastes in the sea or inland bodies of water has in recent years been outlawed for all practical purposes. In both sanitary landfill and open dumping methods, substantial settlement of the material occurs during decomposition, together with production of gaseous emissions. Open dumping, the most common practice used in the disposal of solid wastes, has in recent years received strong criticism from governmental agencies and the general public. The only currently acceptable method of disposal by landfill is management of sanitary landfills adhering to accepted standards of construction and daily maintenance. Continuing studies on sanitary landfills are being conducted in efforts to produce land on completion of such operations that will have a wider range of use than current experience indicates is permissible.

The above broadly indicates the total range of disposal methods currently available. For purposes of this report, we are primarily concerned with selection of ultimate disposal methods that are suitable for the special categories of wastes commonly generated in hospitals, office buildings and detention facilities. From the foregoing studies covered in Volume I and II, quantities, types and characteristics of waste produced at each of these types of facilities, together with an evaluation of present disposal methods employed, were explored in some depth. Based upon these studies, the following criteria in the selection of disposal methods for each building type was established.

Hospital Wastes: The evaluation of hospital solid waste systems indicated that maintaining separate collection channels for contaminated and non-contamined wastes cannot be practically or economically enforced in the conventional hospital facility. Segregation of waste materials throughout the system must rely heavily on the human element of judgment in the classification and distinction of these types of materials. Generally, an intermix of materials occurs due to difficulty of identification and the inability of the workers to make a distinction. Even intermixing of disposables and reusables is commonplace. As a result of these observations, this study has adopted the theory that all wastes coming off the hospital floor can be classified as contaminated materials. It must be pointed out that such classification of hospital wastes is not currently accepted by all authorities. Composition of these wastes include many salvageable materials that could prove harmful upon reclamation and reuse. Based upon these conditions, it was concluded that on-site disposal should be preferred or on-site processing of these materials should be accomplished to produce a sterile homogeneous material suitable for safe off-site transport and disposal.

Office Building Wastes: Composition of wastes generated in the office buildings studied were neither hazardous nor objectionable when related to handling or disposal. Largely consisting of paper with an intermix of small quantities of food wastes and non-combustibles, these materials are generated in relatively low volumes. No restrictions appear necessary on the disposal of materials of this type. However, in interests of security of confidential information, as well as general building safety, consideration should be given to first stage processing of this material such as shredding and/or compaction or baling preceding ultimate disposal. Selection of disposal methods will likely be limited to incineration and landfill or salvage where quantities of materials warrant.

Detention Facilities: Disposable wastes generated in detention facilities were previously identified as rubbish and food wastes not unlike general municipal wastes. It was found in earlier investigations that detention facility waste systems are largely operated by inmates and equipment in this operation is intentionally limited. It was concluded that on-site processing or disposal involving mechanical equipment subject to the operational abuse by inmates should be avoided and that off-site disposal would be preferred. Nature of the waste materials present no greater hazards in disposal than in normal municipal wastes and may satisfactorily be disposed of by conventional methods such as landfilling or incineration.

The continuing research and investigation involved review of the various disposal processes and the combinations of equipment components for processing solid wastes, in efforts to identify, select and evaluate satisfactory disposal systems for the various types of buildings under study. These concluding studies are incorporated in full in Volume IV and summarized in Chapter VI of this volume.

SUMMARY

One of the primary objectives of this study has been the consideration of existent and available systems for the efficient handling of the wastes generated in multistory building complexes and hospitals, which would carry solid wastes from their many points of origin to a place or places of ultimate processing or disposal, without human handling or hazards to health. Despite the advanced state of development of general materials handling equipment, tried and proven mechanical components designed exclusively for solid waste handling are almost non-existent, with the exception of chutes and pneumatic conveyor systems. Various types of conveyors used in industry (such as screw conveyors, belt conveyors, chain conveyors, etc.), however, have been adapted to certain components of waste handling and disposal systems.

Various types of processing and disposal equipment (such as compactors, balers, grinders, pulpers, incinerators, etc.), all offering a wide range of capacities, have been developed for solid waste systems in buildings. Continuing improvements are being made in the evolution of this type of equipment.

Reduced space requirements can be accomplished with the use of waste reduction devices, and building sanitation and safety can be improved with modern compactor container storage. Interim storage points in multistory building complexes can be minimized with the use of pneumatic conveyors whereby nearly instant removal of wastes can be accomplished.

Substantial progress is being made in the development of individual components, but generally the total system concept has not yet been developed and marketed that will provide solutions to all of the many different problems in building complex systems.

A brief recapitulation of the many problems encountered in the building types under study and review of the varieties of equipment available further confirm this observation. This is most emphatically so where a waste system installation is considered for existing structures. The existing layout of floor areas, assigned use and space limitations due to existing mechanical installations impose restrictions upon a free choice of methods and equipment presently available.

The solution to these problems in both existing buildings and those in planning stages requires engineering design of the total system. Design of systems in existing buildings generally requires the following:

1. Analysis of planned building areas and functions and future expansions.

2. Identification of types and quantities of wastes to be generated by building areas.

3. Review applicable code requirements affecting waste handling.

4. Establish range of locally approved disposal methods.

5. Establish range of processing and disposal methods to consider.

6. Establish range of handling methods to consider.

7. Establish range of storage methods to consider.

8. Evaluate economic and environmental aspects of workable combinations of handling, storage and processing.

In addition to the above, design of systems in buildings in the planning stage should also consider the following:

1. Study of general materials handling requirements (quantities and types of new materials at receiving, storage, processing and distribution points).

2. Evaluate merit of common conveyor system for new materials and waste materials.

The rate at which progress is being made in the development of more sophisticated handling and disposal equipment may well make some portions of this report outdated almost before publication. Daily, new material could be added or superseded. It must be recognized that during any period of great technological progress, no precise time could be totally ideal for such a study to be made and the process of updating is a continuing one. New handling methods and treatment processes are being developed, but which are, as yet, untested under working conditions. Some of the equipment known to exist is of foreign origin and not yet installed or proven under operating conditions in the United States. Other equipment or methods, some of which have been seen by the consultant, are still in the development or pilot plant stages and the sponsors have placed restrictions upon disclosure of details at the present time.

In conclusion, it is strongly recommended that continuing investigations be carried out in efforts to stay abreast of developments in this field.

CHAP. VI SELECTION AND DESIGN OF SOLID WASTE SYSTEMS — Page No.

LIST OF TABLES

LIST OF FIGURES

The preceding sections of studies have developed background data identifying the functions and components of solid waste systems in the various types of building complexes under study. Observations of these systems in selected local buildings have recorded the prevailing level of operating standards, the mechanics, and efficiencies or deficiencies, in their existing operation. Further evaluations have indicated the environmental effects and costs of operation of the various components within these building systems, all as a means of identifying weaknesses and needed improvements.

Concurrently with these observations, an investigation was conducted to establish the present "state-of-the-art" in methods and equipment developed for or adaptable to solid waste systems in buildings. Basic guidelines have been advanced for defining system requirements in these various types of buildings, and procedures have been suggested for the evaluation of methods and equipment in the design of workable systems for buildings in the design stage as well as existing buildings.

The concluding phase of this study is broadly concerned with the evaluation of various feasible methods of improvements to solid waste systems in existing buildings and specifically to the solid waste systems of selected County-owned and operated building complexes previously investigated. Complete details of the continuing study are recorded in Volume IV of this report. The principal objective of the continuing study is the determination of methods of storage, handling, processing and disposal that can best be employed where warranted to improve the operating efficiencies of solid waste systems in these existing buildings. This determination involves the investigation of statutes, regulations and codes as they may affect the selection, installation and operation of equipment components in the system. Comparisons of installation and operating costs and benefits of those systems suitable for each type of building are also made and conclusions are presented together with positive recommendations for system improvements.

Organization of Material:

Presentation of material as contained in Volume IV incorporates (1) a digest of principal codes and regulations locally applicable to solid waste systems and management, (2) the evaluation of various types of system improvements considered for selected buildings, and (3) the description of proposed solid waste system modifications at the LAC-USC Medical Center, cost estimates and analysis of benefits of this project, together with an outline of a continuing studies program.

In review of this volume of material, the following digest was prepared, summarizing the requirements of system concepts, evaluation procedures and the conclusions of these evaluations.

MODIFICATION OF HOSPITAL WASTE SYSTEMS

From the descriptions of existing systems in local hospitals detailed in Volume II, critical problems were identified that are common to the majority of hospitals visited across the country and likely common to nearly all hospitals in general. Observations at these local hospitals indicate comprehensive policies have been adopted regarding solid waste management. Generally, these policies are adequate, including specific directives for segregation and special handling of hazardous materials. Practical enforcement of these policies is where the systems break down. Inadequacies in performance are largely due to the "people factor" built into the system and the inability of the workers to make correct judgments consistently.

Upgrading of the conventional solid waste system may be approached in several ways. For example, immediate solutions may be considered for improving methods in handling an individual type of waste or minor modifications of selected functions within the system.

Those unacceptable conditions in the existing waste system should be met with interim remedial measures until such time as acceptable long range solutions can be considered and adopted. These interim remedial measures would generally be confined to policy enforcement and would rely largely on the capabilities of supervisors and cooperation of workers. Such changes can only be implemented and carried out successfully when accompanied by a continuing surveillance program. The value and benefits of a sanitarian carrying among his duties the responsibility for surveillance of the total solid waste system would be indispensable. In those hospitals inspected, the prevailing lack of surveillance of the solid waste system operation was evident. It is reasonable to expect such surveillance with the cooperation of supervisory personnel would have marked effect on working personnel and conditions of the entire system. Concentration on improvements of initial preparation of wastes, i.e. devising workable methods of breaking, packaging or containerizing disposable syringes, needles, instruments, etc. at the ward level would reduce hazards in handling and the possibility of ultimate reuse. Improvements in maintaining proper handling and disposal of pathological wastes, separation of reusables and disposables, proper bagging of materials, prompt deposit of materials in chutes, close supervision of storage, processing and disposal areas and maintaining security in these areas against access by unauthorized personnel are needed improvements that will lead to a more nearly acceptable level of operation and that may be accomplished through a continuing surveillance program. In the conventional waste system in the larger institutions, which relies totally on the performance of manpower, costs of intensive supervision and surveillance will be relatively high, but are necessary if attempting to implement such an interim remedial program.

Conversely, the total system may be modified with the design of a single integrated closed system to handle all types of materials insofar as practical. With the development of a modified system whereby the majority of waste materials can be conveyed in a mechanized closed transport system, such surveillance will be limited to initial handling techniques at the ward level and final handling at the processing and disposal stations.

System Criteria:

The necessity of a closed system for the transfer, storage, processing and disposal of hospital wastes is founded on the premise that all such wastes are contaminated. This is based on observations that segregation of identifiable contaminated and uncontaminated waste materials is neither accomplished in practice nor likely to be practically or economically enforced. Composition of these wastes include many salvageable materials that could prove harmful upon reclamation and reuse. In the interest of public health and welfare, it was concluded that in addition to the closed transport system, on-site disposal should be preferred or on-site processing of these materials should be accomplished to produce a sterile homogeneous material suitable for safe off-site transport and disposal.

Capabilities of presently developed equipment are not sufficiently flexible to achieve a closed system design that will handle all wastes from point of generation through a point of disposal in either new buildings or modifications of systems in existing buildings. However, it does appear feasible that systems can be assembled that will handle the majority of these materials from centrally located accumulation points on each floor to central storage or processing locations.

Handling Requirements:

Due to the prevailing high ratio of reusable soiled linens to disposable wastes, it appeared necessary for the selected waste handling system to have the capabilities of moving both materials. General materials handling systems, either of the automated mechanical conveyor type or automated cart type, could not be adapted within these existing buildings due to physical plant layout, limitations of space, conflicts with internal traffic elements and mechanical and structural obstacles. The only alternative handling system available, having the required capabilities, that could be adapted within existing plants appeared to be pneumatic conveyors. Although twin tube systems are available for separate handling of linens and wastes, consideration has been limited herein to the single tube system based on lesser space requirements and economy. Flexibility in adapting this type of system within the existing building would permit collection from the base of chutes without extensive modifications to the existing chute system. Evacuation of accumulated materials could be accomplished at frequent intervals, transferring the materials to their respective central storage locations.

Storage Requirements:

This closed system concept also favors elimination of storage and rehandling of wastes. With the use of the pneumatic conveyor system, intermediate storage requiring physical rehandling after deposit in the chutes would be eliminated. With the added consideration of placing the vertical chutes under slight negative pressure to minimize aerosol contamination, the transport system would meet the desired level of environmental standards which the closed system can provide. Utilization of automated mechanical conveyors or cart systems (which are more adaptable to buildings in the design stage) for the transport of sealed containers would afford a similar level of environmental standards providing space availability would permit their use. In either case, the only storage elements required in these types of closed systems are the initial storage facilities in the Unit system and central storage in the Inter-Building system.

Processing and Disposal Requirements:

Considering the criteria established for disposal of contaminated hospital wastes, a number of methods have been evaluated. These methods identified below are listed in their order of desirability.

1. Transportation of pulped or ground hospital wastes in the sanitary sewer system with on-site sterilization or subsequent sterilization, oxidation and digestion at an off-site treatment plant will assure freedom from contamination hazards.

2. Transportation and landfill of residue from hospital refuse after thorough on-site incineration or pyrolysis is a safe method without danger of contamination.

3. Transportation and landfill disposal of hospital refuse after pulping or grinding and sterilization is a safe method without danger of contamination.

4. Transportation of pulped or ground hospital waste in the sanitary sewerage system with dewatering and disposal at an off-site treatment plant should be a satisfactory system for limited quantities of hospital refuse.

5. Transportation and landfill disposal of hospital refuse, modified by grinding and extruded with a binding agent into blocks and encapsulated, while minimizing hazards during transport and handling, is still subject to spreading contamination at the disposal site by rupture of the casing during compaction operations.

6. Transportation and landfill disposal of hospital refuse modified by grinding or pulping will reduce some hazards in handling at the disposal site but may cause the spread of contamination in transport and disposal.

7. Transportation and landfill disposal of baled or compacted hospital refuse, while lessening dangers to handlers, the material is subject to scavenging of hazardous reusable materials and the spread of contamination in transport and at the disposal site.

8. Transportation and landfill disposal of loose hospital refuse is dangerous to handlers and the public alike and is subject to scavenging of hazardous materials and the spread of contamination along the transport route and at the disposal site.

Of the eight methods of processing and disposal considered above, only four (Nos. 1-4) reasonably meet the established criteria (page VI-3) and have sufficient qualifications to warrant serious consideration from an environmental point of view.

Of these four, only two (Nos. 2 and 3) fully meet the established criteria, wherein incineration and sterilization after pulping convert the wastes for safe off-site handling. Two additional methods, differing only slightly and both involving pulping, utilize the already contaminated sewers as the means of off-site transport. These methods would not contribute additional environmental contamination in transport and in principle also meet the criteria. Method No. 1 provides for further modifications of pulped solids by the wet oxidation process. This may be accomplished prior to discharge to sewers or at the sewage treatment plant by modification of treatment processes. In the latter case, the wet oxidation process would be handling the full range of solids presently encountered in addition to the pulped hospital waste loadings. Method No. 4 without further modification of pulped solids prior to discharge to the sewers or without modification of sewage treatment processes would burden the treatment plants with the quantitative increase in contaminated solid materials these plants will handle.

Methods 5 and 6, while not reducing dangers from contamination do reduce hazards in handling, eliminate scavenging and are a considerable improvement over present off-site handling methods. Such processes could be considered on an interim basis until such time as the system could be further upgraded.

Effect on Community:

In evaluation of these processing and disposal methods, the magnitude of the total hospital waste problem in the community must be weighed and related to in-plant environment and the environment of the community at large. For example, in Los Angeles County, some 580 hospitals and nursing homes have a potential daily generation of about 470,000 pounds or 235 tons of disposable wastes. This quantity of materials is presently handled at the respective institutions daily and disposed of by incineration or transported to landfills for disposal.

In addition to the problems of in-plant handling, potential hazards to the community exist in the off-site handling of this material. No conclusive research directly related to off-site disposal of hospital wastes and its effect on the community has been performed. Principal concerns of health authorities relate to the possible survival of pathogenic microorganisms and their subsequent transmission by direct human contact with contaminated materials or through insects or rodents, as well as transmission through air and water pollution. Off-site disposal conventionally involves a method of highway transport, direct or via transfer stations to landfills or other disposal facilities. The community environment may be exposed to hospital waste contaminants throughout the course of travel with greatest potential exposure occurring at the disposal site where direct contact by refuse workers and scavengers may occur or where water pollution via runoff or leaching may ultimately occur.

Although incineration is one of the most effective methods, its continuing use cannot be recommended in this area because of the severe air pollution which already exists under certain atmospheric conditions.

Considering pulping with discharge to sewers as an alternative, a potential loading of about 70% of this total daily generation of hospital wastes or 165 tons (dry weight) would be handled daily at the sewage treatment plants in Los Angeles, discounting mositure content and non-pulpable material. With conventional sewage treatment processes, the nature and quantity of these solids would in truth be a burden if all such materials were received and processed. However, with modifications of sewage treatment processes, adapting such methods as wet oxidation, all solids may be substantially reduced in quantity and handled at a much faster rate than conventional processes permit.

The solution for the total community problem in handling hospital wastes could be achieved if pulping or grinding with discharge to sewers can be proven feasible and accepted by local authorities. Hospitals, nursing homes, clinics, etc. where contaminated wastes are concentrated could utilize a recognized contaminated transport channel (the sewer) with disposal at limited and controlled locations (sewage treatment plants). Personnel at these plants are accustomed and trained in handling and processing such contaminated materials in a routine manner with reasonable safeguards to the community environment.

A concurrent research project conducted by the County of Los Angeles Health Department has investigated wet grinding of hospital wastes with discharge to sewers. This *research carried out during 1967-69 employed the use of small pilot grinder installations at selected local hospitals wherein selected hospital wastes

*"Use of Wet Grinding Units for Disposal of Hospital Solid Wastes" - by Bernard S. Weintraub, Harvey D. Kern, Health Facilities Service Division, County of Los Angeles, Health Department, Aug. 1969 - Research Grant 110-224 Health Facilities Planning [illegible]. Public Health Service

were satisfactorily processed. The study concluded that such processing with subsequent discharge to sewers is a feasible and an appealing public health solution to a major community problem and suggested that more intensive research was warranted for this method of disposal.

Evaluation of System Modifications:

It must be reemphasized that selection of the solid waste systems or systems modifications for hospitals should not be governed solely by favorable economics. The evaluation of solid waste systems must consider the environmental aspects of operation as well as the economic aspects, not unlike the evaluations which have contributed to the evolution and continuing improvement of sanitary systems for handling contaminated liquid (sewage) wastes generated in all types of buildings.

The environmental aspects considered in the evaluation of the solid waste system modifications in those institutions under study follow the same procedures as were applied in the evaluation of existing systems. This evaluation method was developed around the closed system concept, wherein the optimum standards of operation throughout the system permit handling, storage, processing and disposal of all wastes to be accomplished without exposure and without contributing additional environmental pollution. Such a system, receiving wastes at the point of generation and transporting this material to a final processing or disposal station would in theory not have an operating deficiency, except possibly in the initial deposit or in the final disposal process. An analogy to this concept is the garbage grinder, receiving and processing food wastes generated in the kitchen, discharging these materials to sewers for transport with final processing and conversion of wastes at the sewage treatment plant.

Based on present technology and equipment in the development stage, it is doubtful that such systems capable of handling all hospital wastes (both reusables and disposables) will be devised and widely used in the foreseeable future.

Considered improvements which most nearly approach this concept, as qualified in the foregoing, have been limited to adaptation of the pneumatic conveyor system for transport of the majority of wastes and the four optional processing and disposal methods that reasonably meet the established criteria. Tabular summaries will later show the comparison between the various systems at each institution.

Costs of the various system improvements were estimated based on cursory investigations of buildings, mechanical installations and site conditions, without benefit of the development of preliminary plans. Sizing of processing and/or disposal units were based on handling of the present quantities of wastes generated during a one shift operation on a seven day week basis. Expansion of disposal facilities and/or increasing number of shifts worked would be required to meet significant future increases in waste production. Manufacturers of various types of equipment were consulted in establishing budgeted costs of improvement. Depreciation costs (straight line basis) of the modified systems have been based on 10 to 25 year life of various elements of the systems. Net investment costs for installation of the modified systems consider total costs of improvements, less salvage allowances for equipment used in the present system that may be retired. Cost allowances for additions or replacement of equipment in the existing system are also considered in the determination of the net investment.

Summaries were prepared on each system identifying the tangible economic benefits (if any) to be derived from the implementation of the project, incorporating those direct operating benefits as noted, together with certain indirect benefits that accrue due to elimination of certain parts of the existing system. Direct operating benefits or advantages consider the direct effects of operational costs of the project, i.e. savings in labor and building areas released for other uses and the increase in costs of maintenance, materials and supplies and power or collectively, the gross savings or added cost of operation. Indirect benefits or non-operating advantages also consider annual savings in further depreciation of the existing system. In some cases, it will be noted that the considered improvements in systems will not reflect such benefits or economies but will, in fact, increase annual operating costs. A tabular summary will later show the comparison of the economic evaluations between the various systems at each institution.

In addition to the tangible benefits, certain intangible benefits with monetary value will also accure as a result of operating the improved solid waste system. Improvement in sanitation, safety, security and esthetics may likely have an effect on the frequency of personal injury, accidents, illness of personnel, as well as patients throughout the plant and perhaps the greatest effect on those being associated with the direct handling of the waste materials. Similarly, limiting the exposure of wastes in transport and off-site disposal would likely have a beneficial effect on the community at large. Improvement in systems operation and these related environmental conditions should also tend to reduce the general cost of building maintenance and losses due to fire or other casualty. These improved systems using an isolated and specialized transport method will reduce congestion in building corridors, allowing more efficient performance of other service functions. Economic analysis of annual dollar savings that may accrue from these benefits would require a multitude of record statistics of plant operation that are not available and adequate bases of fact are not at hand to permit an intelligent detailed estimate. However, it is conceivable that collectively the intangible benefits could equal, if not exceed, the estimated value of tangible benefits in many cases.

Identification of Considered System Modifications:

Reference to the identification of those modified systems considered in the evaluations will be limited to ID numbers established as follows:

1 - Pneumatic Conveyor System, Pulping or Wet Grinding, Wet Oxidation, Discharge to Sewers

2 - Pneumatic Conveyor System, Incineration, Transport Residue to Landfill

3 - Pneumatic Conveyor System, Pulping or Wet Grinding, Wet Oxidation, Dewater, Transport to Landfill

4 - Pneumatic Conveyor System, Pulping, Discharge to Sewers

5 - Pneumatic Conveyor System, Pulping or Wet Grinding, Extrude, Transport to Landfill

6 - Pneumatic Conveyor System, Shredding, Transport to Landfill

7 - Pneumatic Conveyor System, Pulping or Wet Grinding, Dewater, Transport to Landfill

8 - Pneumatic Conveyor System, Stationary Compactor, Transport to Landfill

9 - Pneumatic Conveyor System, Packer Truck, Transport to Landfill

Only those systems (Nos. 1-4) which meet the established criteria for satisfactory disposal were considered in the environmental evaluation (numerical rating) of modified systems. However, cost comparisons of all these systems were made to provide an overall "yardstick" in the range of costs of disposal and the significance of such costs.

These system evaluations as presented in Volume IV included detailed numerical ratings, estimated project costs, estimated daily labor costs and the economic analysis of these system improvements at each institution. Repetition of this volume of data is not warranted herein and the reader is referred to Volume IV for complete details. However, to illustrate the depth of these evaluations, the report on the LAC-USC Medical Center is appended (Appendix F) in its entirety for the reader's convenience.

Summary:

In review of the evaluation of system modifications as presented in Volume IV, Table VI-1 was prepared in summary of these findings, showing comparisons in system deficiencies, investment requirements and increase or decrease in annual costs.

Based on investment requirements and the effect on annual costs of operation of the four systems considered, System 4 (pulping with discharge of wastes to sewers) has considerable merit, while at the same time improving in-plant conditions as well as off-site handling.

The solution for the total community problem in off-site handling of hospital wastes could be achieved if pulping or grinding with discharge to sewers can be proven feasible and accepted by local authorities. Hospitals, nursing homes, clinics, etc. where contaminated wastes are concentrated could utilize a recognized contaminated transport channel (the sewer) with disposal at limited and controlled locations (sewage treatment plants). Personnel at these plants are accustomed and trained in handling and processing such contaminated materials in a routine manner with reasonable safeguards to the community environment. Based on local environmental conditions and needs, further development of this concept is warranted.

Comparison of Hospital Solid Waste Systems

TABLE VI-1 EFFECT OF SYSTEM MODIFICATIONS

	LAC-USC Medical Center	Long Beach General Hospital	Harbor General Hospital	Rancho Los Amigos Hospital	John Wesley Hospital	Olive View Hospital	Mira Loma Hospital	Total All Hospitals	% Return on Investment
COMPARISON OF SYSTEM DEFICIENCIES									
Existing System	58%	25%	37%	20%	26%	36%	29%	--	--
Considered System Modifications:									
System 1	20.6%	9.9%	12.6%	9.0%	11.1%	10.1%	11.2%	--	--
System 2	20.8%	10.1%	12.8%	9.2%	11.5%	10.3%	12.3%	--	--
System 3	23.2%	12.5%	15.2%	11.6%	13.8%	12.7%	13.9%	--	--
System 4	24.4%	13.7%	16.4%	12.8%	15.0%	14.0%	15.0%	--	--
EXISTING ANNUAL OPERATING COSTS	$2,396,850	$223,600	$777,435	$ 656,340	$296,582	$750,585	$175,200	$5,276,592	--
COSTS OF SYSTEM MODIFICATIONS:									
System 1 - Net Investment	$2,292,000	$645,000	$698,000	$1,732,800	$594,800	$587,100	$415,000	$6,964,700	
*Annual Cost Difference	(389,250)	45,500	(54,700)	58,900	(2,400)	(29,200)	(8,300)	(379,450)	5.4%
System 2 - Net Investment	$2,272,000	$500,000	$573,000	$1,667,800	$459,800	$412,100	$275,000	$6,159,700	
*Annual Cost Difference	(428,325)	21,500	(74,400)	24,000	(22,100)	(30,500)	(15,200)	(525,025)	8.5%
System 3 - Net Investment	$2,317,000	$647,000	$718,000	$1,752,800	$614,800	$607,100	$435,000	$7,091,700	
*Annual Cost Difference	(379,900)	53,400	(37,900)	75,200	6,100	(12,900)	1,200	(294,800)	4.2%
System 4 - Net Investment	$1,932,000	$495,000	$498,000	$1,507,800	$444,800	$387,100	$290,000	$5,554,700	
*Annual Cost Difference	(431,200)	27,500	(76,100)	22,200	(20,100)	(50,000)	(22,300)	(594,400)	10.7%

*Increase or decrease ( ) over annual operating costs of the existing solid waste system, including annual depreciation expense for buildings and equipment but, excluding interest expense and any additional off-site disposal costs that may be assessed.

MODIFICATION OF OFFICE BUILDING WASTE SYSTEMS

The evaluations of existing systems in the office buildings under study, as reported in Volume II, indicate these systems are operated with reasonable economy and with relatively minor deficiencies.

These investigations found that these systems are operated largely without specialized equipment by custodial work forces as they perform daily routine cleaning and maintenance functions. This work is generally performed when buildings are unoccupied, thereby permitting effective supervision and control of these activities.

Composition of wastes generated in the office buildings studied were neither hazardous nor objectionable when related to handling or disposal. Largely consisting of paper with an intermix of small quantities of food wastes and non-combustibles, these materials are generated in relatively low volumes.

The numerical rating, reflecting the environmental aspects of these evaluations, identified that the major deficiencies exist in storage functions and the off-site system. These deficiencies are relatively minor by comparison to those found in the hospital waste systems. Upgrading of these systems as in the case of hospitals requires adopting higher standards of operation. The motivation for adopting such standards is multipurpose; to improve building safety and safety of occupants through elimination of fire hazards and conservation of space through minimizing storage. Based upon the equipment research undertaken in this study, there are limited mechanical devices that can be employed to help achieve such improvements. Such improvements for these buildings will require additional capital investments and likely result in higher annual costs than presently experienced.

System Criteria:

Minimum modifications that may be considered, limited to such installations as gravity chutes and/or stationary compactors or balers, will require only nominal investments and accomplish the basic objective of improving on-site storage deficiencies.

Major modifications, eliminating in-building storage entirely, may be feasible in major building complexes. Such systems, employing pneumatic conveyor systems, could evacuate materials deposited in gravity chutes in each building and convey these materials to a central storage or processing point. Such processes, including compaction or baling, pulping or grinding and incineration, may be considered as the final on-site treatment of wastes. However, due to the severity of air pollution in the Los Angeles Basin, the latter has not been considered suitable for the Civic Center buildings under study.

Identification of Considered System Modifications:

Reference to the identification of those modified systems considered in the evaluations will be limited to the ID numbers established as follows:

1 - Manual Fed Stationary Compactor (System serves single building), Continued Transport to Sanitary Landfill

2 - Gravity Chutes, Pneumatic Conveyor System, Central Stationary Compactor (System serves several buildings), Continued Transport to Sanitary Landfill

3 - Gravity Chutes, Pneumatic Conveyor System, Central Wet Grinding Station, Discharge to Sewers and/or Reclamation of Pulp (System serves several buildings)

4 - Gravity Chute, Stationary Compactor (System serves single building), Continued Transport to Sanitary Landfill

Evaluation of Modified Systems:

The procedures in evaluation of office building systems follow the same procedures as outlined earlier for hospitals. The following evaluations of the modified systems include tabular and graphic illustrations of the numerical ratings, estimated project costs, estimated daily labor costs and the economic analysis of such modifications considered at the four office buildings under study. The above described systems are considered at each of these buildings except the Engineers Building, wherein, due to the remote location from the tunnel system connecting the Civic Center buildings, only systems 1 and 4 may be feasible.

TABLE VI-2 NUMERICAL RATING OF OFFICE BUILDING SOLID WASTE SYSTEMS

SYSTEMS 1 & 4

System Components			HALL OF RECORDS				HALL OF ADMINISTRATION				COUNTY COURTHOUSE				ENGINEERS BUILDING			
			RUBBISH		Total		RUBBISH		Total		RUBBISH		Total		RUBBISH		Total	
			Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value
UNIT SYSTEM	Initial Deposit (Receiver)	Sanitation	2	10	9	40	2	10	9	40	2	10	9	40	2	10	9	40
		Safety	1	5			1	5			1	5			1	5		
		Security	1	5			1	5			1	5			1	5		
		Esthetics	5	20			5	20			5	20			5	20		
	Initial Transfer	Sanitation	2	10	5	30	2	10	5	30	2	10	5	30	2	10	5	30
		Safety	1	5			1	5			1	5			1	5		
		Security	0	5			0	5			0	5			0	5		
		Esthetics	2	10			2	10			2	10			2	10		
	Initial Storage, Processing, Disposal	Sanitation		5		55		5		55		5		55		5		55
		Safety		15				15				15				15		
		Security		15				15				15				15		
		Esthetics		20				20				20				20		
	Total	Sanitation	4	25	14	125	4	25	14	125	4	25	14	125	4	25	14	125
		Safety	2	25			2	25			2	25			2	25		
		Security	1	25			1	25			1	25			1	25		
		Esthetics	7	50			7	50			7	50			7	50		
INTER-UNIT SYSTEM	Internal Transfer	Sanitation	5	25	12	60	5	25	12	60	5	25	12	60	5	25	12	60
		Safety	3	15			3	15			3	15			3	15		
		Security	2	10			2	10			2	10			2	10		
		Esthetics	2	10			2	10			2	10			2	10		
	Central Storage	Sanitation		10		75		10		75		10		75		10		75
		Safety		25				25				25				25		
		Security		30				30				30				30		
		Esthetics		10				10				10				10		
	Central Processing or Disposal	Sanitation	4	15	17	40	4	15	17	40	4	15	17	40	4	15	17	40
		Safety	5	10			5	10			5	10			5	10		
		Security	5	10			5	10			5	10			5	10		
		Esthetics	3	5			3	5			3	5			3	5		
	Total	Sanitation	9	50	29	175	9	50	29	175	9	50	29	175	9	50	29	175
		Safety	8	50			8	50			8	50			8	50		
		Security	7	50			7	50			7	50			7	50		
		Esthetics	5	25			5	25			5	25			5	25		
OFF-SITE SYSTEM	External Transfer	Sanitation	2	10	5	30	2	10	5	30	2	10	5	30	2	10	5	30
		Safety	2	10			2	10			2	10			2	10		
		Security	0	5			0	5			0	5			0	5		
		Esthetics	1	5			1	5			1	5			1	5		
	Final Processing and/or Disposal	Sanitation	3	15	50	70	3	15	50	70	3	15	50	70	3	15	50	70
		Safety	12	15			12	15			12	15			12	15		
		Security	20	20			20	20			20	20			20	20		
		Esthetics	15	20			15	20			15	20			15	20		
	Total	Sanitation	5	25	55	100	5	25	55	100	5	25	55	100	5	25	55	100
		Safety	14	25			14	25			14	25			14	25		
		Security	20	25			20	25			20	25			20	25		
		Esthetics	16	25			16	25			16	25			16	25		
TOTAL		Sanitation	18	100	98	400	18	100	98	400	18	100	98	400	18	100	98	400
		Safety	24	100			24	100			24	100			24	100		
		Security	28	100			28	100			28	100			78	100		
		Esthetics	28	100			28	100			28	100			28	100		

TABLE VI-3 NUMERICAL RATING OF OFFICE BUILDING SOLID WASTE SYSTEMS

SYSTEM 2

	System Components		HALL OF RECORDS				HALL OF ADMINISTRATION				COUNTY COURTHOUSE							
			RUBBISH		Total		RUBBISH		Total		RUBBISH		Total		RUBBISH		Total	
			Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value
UNIT SYSTEM	Initial Deposit (Receiver)	Sanitation	2	10	9	40	2	10	9	40	2	10	9	40		10		40
		Safety	1	5			1	5			1	5				5		
		Security	1	5			1	5			1	5				5		
		Esthetics	5	20			5	20			5	20				20		
	Initial Transfer	Sanitation	2	10	5	30	2	10	5	30	2	10	5	30		10		30
		Safety	1	5			1	5			1	5				5		
		Security	0	5			0	5			0	5				5		
		Esthetics	2	10			2	10			2	10				10		
	Initial Storage, Processing, Disposal	Sanitation		5		55		5		55		5		55		5		55
		Safety		15				15				15				15		
		Security		15				15				15				15		
		Esthetics		20				20				20				20		
	Total	Sanitation	4	25	14	125	4	25	14	125	4	25	14	125		25		125
		Safety	2	25			2	25			2	25				25		
		Security	1	25			1	25			1	25				25		
		Esthetics	7	50			7	50			7	50				50		
INTER-UNIT SYSTEM	Internal Transfer	Sanitation	5	25	5	60	5	25	5	60	5	25	5	60		25		60
		Safety	0	15			0	15			0	15				15		
		Security	0	10			0	10			0	10				10		
		Esthetics	0	10			0	10			0	10				10		
	Central Storage	Sanitation		10		75		10		75		10		75		10		75
		Safety		25				25				25				25		
		Security		30				30				30				30		
		Esthetics		10				10				10				10		
	Central Processing or Disposal	Sanitation	4	15	6	40	4	15	6	40	4	15	6	40		15		40
		Safety	2	10			2	10			2	10				10		
		Security	0	10			0	10			0	10				10		
		Esthetics	0	5			0	5			0	5				5		
	Total	Sanitation	9	50	11	175	9	50	11	175	9	50	11	175		50		175
		Safety	2	50			2	50			2	50				50		
		Security	0	50			0	50			0	50				50		
		Esthetics	0	25			0	25			0	25				25		
OFF-SITE SYSTEM	External Transfer	Sanitation	2	10	5	30	2	10	5	30	2	10	5	30		10		30
		Safety	2	10			2	10			2	10				10		
		Security	0	5			0	5			0	5				5		
		Esthetics	1	5			1	5			1	5				5		
	Final Processing and/or Disposal	Sanitation	3	15	50	70	3	15	50	70	3	15	50	70		15		70
		Safety	12	15			12	15			12	15				15		
		Security	20	20			20	20			20	20				20		
		Esthetics	15	20			15	20			15	20				20		
	Total	Sanitation	5	25	55	100	5	25	55	100	5	25	55	100		25		100
		Safety	14	25			14	25			14	25				25		
		Security	20	25			20	25			20	25				25		
		Esthetics	16	25			16	25			16	25				25		
TOTAL		Sanitation	18	100	80	400	18	100	80	400	18	100	80	400		100		400
		Safety	18	100			18	100			18	100				100		
		Security	21	100			21	100			21	100				100		
		Esthetics	23	100			23	100			23	100				100		

TABLE VI-4 NUMERICAL RATING OF OFFICE BUILDING SOLID WASTE SYSTEMS

SYSTEM 3

System Components			HALL OF RECORDS				HALL OF ADMINISTRATION				COUNTY COURTHOUSE							
			RUBBISH		Total		RUBBISH		Total		RUBBISH		Total		RUBBISH		Total	
			Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value
UNIT SYSTEM	Initial Deposit (Receiver)	Sanitation	2	10	9	40	2	10	9	40	2	10	9	40		10		40
		Safety	1	5			1	5			1	5				5		
		Security	1	5			1	5			1	5				5		
		Esthetics	5	20			5	20			5	20				20		
	Initial Transfer	Sanitation	2	10	5	30	2	10	5	30	2	10	5	30		10		30
		Safety	1	5			1	5			1	5				5		
		Security	0	5			0	5			0	5				5		
		Esthetics	2	10			2	10			2	10				10		
	Initial Storage, Processing, Disposal	Sanitation		5		55		5		55		5		55		5		55
		Safety		15				15				15				15		
		Security		15				15				15				15		
		Esthetics		20				20				20				20		
	Total	Sanitation	4	25	14	125	4	25	14	125	4	25	14	125		25		125
		Safety	2	25			2	25			2	25				25		
		Security	1	25			1	25			1	25				25		
		Esthetics	7	50			7	50			7	50				50		
INTER-UNIT SYSTEM	Internal Transfer	Sanitation	5	25	5	60	5	25	5	60	5	25	5	60		25		60
		Safety	0	15			0	15			0	15				15		
		Security	0	10			0	10			0	10				10		
		Esthetics	0	10			0	10			0	10				10		
	Central Storage	Sanitation		10		75		10		75		10		75		10		75
		Safety		25				25				25				25		
		Security		30				30				30				30		
		Esthetics		10				10				10				10		
	Central Processing or Disposal	Sanitation	4	15	6	40	4	15	6	40	4	15	6	40		15		40
		Safety	2	10			2	10			2	10				10		
		Security	0	10			0	10			0	10				10		
		Esthetics	0	5			0	5			0	5				5		
	Total	Sanitation	9	50	11	175	9	50	11	175	9	50	11	175		50		175
		Safety	2	50			2	50			2	50				50		
		Security	0	50			0	50			0	50				50		
		Esthetics	0	25			0	25			0	25				25		
OFF-SITE SYSTEM	External Transfer	Sanitation	0	10	0	30	0	10	0	30	0	10	0	30		10		30
		Safety	0	10			0	10			0	10				10		
		Security	0	5			0	5			0	5				5		
		Esthetics	0	5			0	5			0	5				5		
	Final Processing and/or Disposal	Sanitation	0	15	0	70	0	15	0	70	0	15	0	70		15		70
		Safety	0	15			0	15			0	15				15		
		Security	0	20			0	20			0	20				20		
		Esthetics	0	20			0	20			0	20				20		
	Total	Sanitation	0	25	0	100	0	25	0	100	0	25	0	100		25		100
		Safety	0	25			0	25			0	25				25		
		Security	0	25			0	25			0	25				25		
		Esthetics	0	25			0	25			0	25				25		
TOTAL		Sanitation	13	100	25	400	13	100	25	400	13	100	25	400		100		400
		Safety	4	100			4	100			4	100				100		
		Security	1	100			1	100			1	100				100		
		Esthetics	7	100			7	100			7	100				100		

TABLE VI-5 COMPARISON OF OFFICE BUILDING PROJECT COSTS

BUILDING	SYSTEM	SYSTEM COMPONENTS	INSTALLED COSTS	ESTIMATED LIFE (YEARS)	DEPRECIATION
HALL OF ADMINISTRATION	1	Compactor	$ 12,000	10	$1,200
	2	Vacuum Tube	$102,200	25	$4,088
		Gravity Chute	4,050	25	162
		Compactors	6,250	10	625
		Building	25,000	25	1,000
		Total	$137,500		$5,875
	3	Vacuum Tube	$102,200	25	$4,088
		Gravity Chute	4,050	25	162
		Grinders	18,750	10	1,875
		Building	25,000	25	1,000
		Total	$150,000		$7,125
	4	Gravity Chute	$ 4,050	25	$ 162
		Compactor	15,000	10	1,500
		Total	$ 19,050		$1,660
COUNTY COURTHOUSE	1	Compactor	$ 12,000	10	$1,200
	2	Vacuum Tube	$102,200	25	$4,088
		Gravity Chute	4,050	25	162
		Compactors	6,250	10	625
		Building	25,000	25	1,000
		Total	$137,500		$5,875
	3	Vacuum Tube	$102,200	25	$4,088
		Gravity Chute	4,050	25	162
		Grinders	18,750	10	1,875
		Building	25,000	25	1,000
		Total	$150,000		$7,125
	4	Gravity Chute	$ 4,050	25	$ 162
		Compactor	15,000	10	1,500
		Total	$ 19,050		$1,660
HALL OF RECORDS	1	Compactor	$ 12,000	10	$1,200
	2	Vacuum Tube	$102,200	25	$4,088
		Gravity Chute	7,650	25	306
		Compactors	6,250	10	625
		Building	25,000	25	1,000
		Total	$141,100		$6,020
	3	Vacuum Tube	$102,200	25	$4,088
		Gravity Chute	7,650	25	306
		Grinders	18,750	10	1,875
		Building	25,000	25	1,000
		Total	$153,600		$7,270
	4	Gravity Chute	$ 7,650	25	$ 306
		Compactor	15,000	10	1,500
		Total	$ 22,650		$1,810
ENGINEERS BUILDING	1	Compactor	$ 12,000	10	$1,200
	4	Gravity Chute	$ 4,050	25	$ 162
		Compactor	15,000	10	1,500
		Total	$ 19,050		$1,660

TABLE VI-6 ESTIMATED DAILY LABOR REQUIREMENTS AND COSTS OF SYSTEMS 2 AND 3

	Hall of Records	Hall of Administration	County Courthouse
REQUIREMENTS OF WASTE SYSTEM:			
Unit System (Man Hrs.)	52.9	85.0	56.6
Inter-Unit System (Man Hrs.)	1.0	1.0	1.0
Total System (Man Hrs.)	53.9	86.0	57.6
ESTIMATED LABOR COSTS:			
Unit System	$ 196	$ 315	$ 210
Inter-Unit System	$ 5	$ 5	$ 5
Total System Cost	$ 201	$ 320	$ 215
Cost/Ton	$ 402	$ 250	$ 246
Cost/Pound	$0.201	$0.125	$0.123

Note: Above cost summary does not include off-site system costs, which are expected to remain generally constant.

Note: Present labor costs are not expected to be affected in System 1.

TABLE VI-7 ESTIMATED DAILY LABOR REQUIREMENTS AND COSTS OF SYSTEM 4

	Hall of Records	Hall of Administration	County Courthouse	County Engineers
REQUIREMENTS OF WASTE SYSTEM:				
Unit System (Man Hrs.)	52.9	85.0	56.6	37.6
Inter-Unit System (Man Hrs.)	2.0	2.0	2.0	1.0
Total System (Man Hrs.)	54.9	87.0	58.6	38.6
ESTIMATED LABOR COSTS:				
Unit System	$ 196	$ 315	$ 210	$ 139
Inter-Unit System	$ 7	$ 7	$ 7	$ 4
Total System Cost	$ 203	$ 322	$ 217	$ 143
Cost/Ton	$ 406	$ 252	$ 248	$ 340
Cost/Pound	$0.203	$0.126	$0.124	$0.170

Note: Above cost summary does not include off-site system costs, which are expected to remain generally constant.

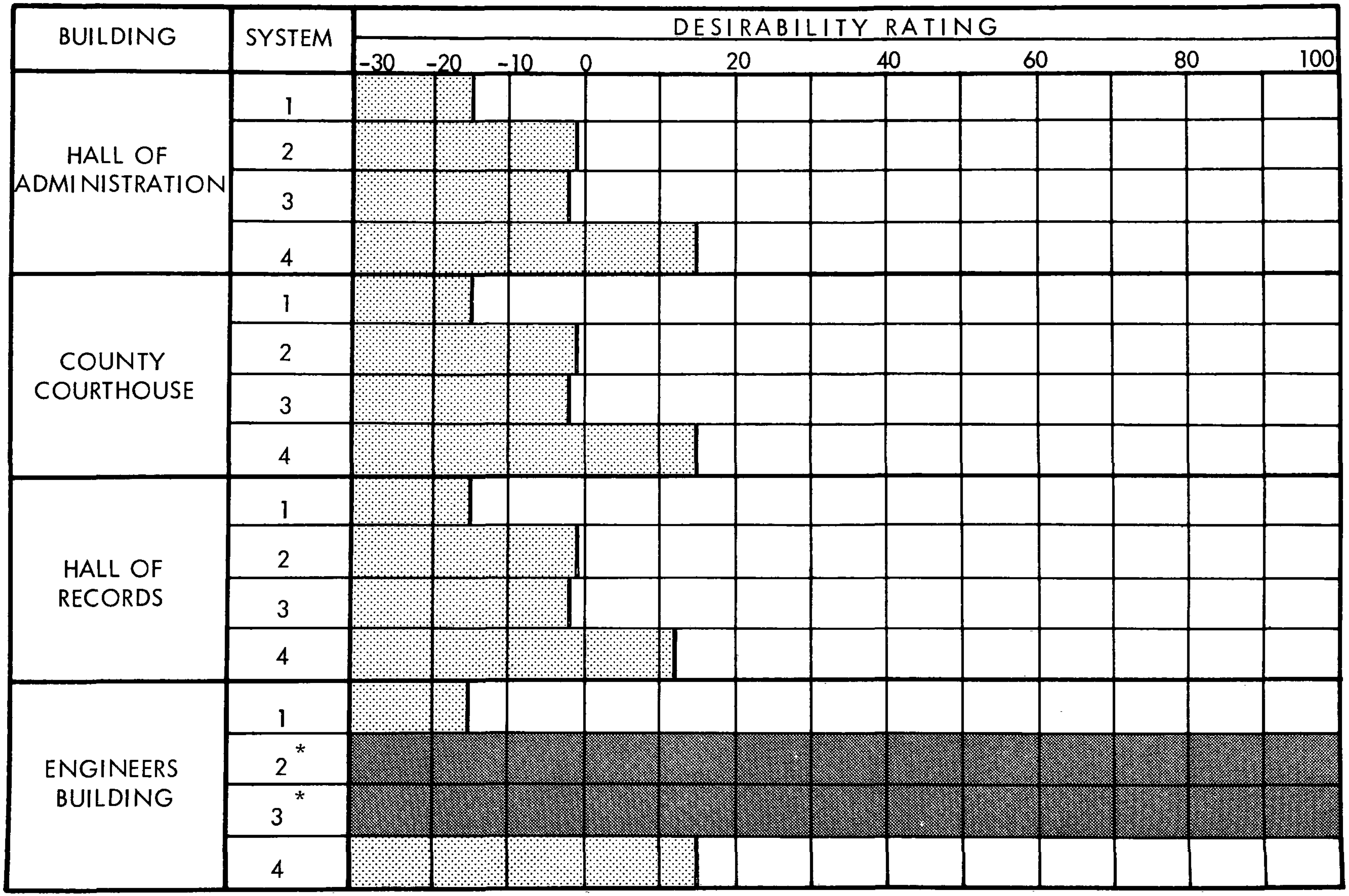
Note: Present labor costs are not expected to be affected in System 1.

TABLE VI-8 ECONOMIC EVALUATION OF SOLID WASTE SYSTEM MODIFICATIONS

OFFICE BUILDING	ITEM	SYSTEM 1		SYSTEM 2		SYSTEM 3		SYSTEM 4	
HALL OF ADMINISTRATION	I INVESTMENT								
	Installed Cost of Project	$ 12,000		$137,500		$150,000		$ 19,050	
	Investment Released or Avoided by Project								
	Net Investment Required	$ 12,000		$137,500		$150,000		$ 19,050	
	II OPERATING ADVANTAGE								
	DIRECT EFFECT OF PROJECT	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease
	Labor		$ 0		$6,350		$6,350		$5,385
	Maintenance	$ 60		$ 690		$ 750		$ 100	
	Materials and Supplies	90		1,030		1,125		150	
	Power	1,090		1,000		1,550		1,245	
	Floor Space		$ 600		$ 600		$ 600		$ 600
	Net Increase or Decrease in Operating Costs	$- 640			$4,230		$3,525		$4,490
	III COMPUTATION OF DESIRABILITY RATING								
	Total Advantage	$- 640		$ 4,230		$ 3,525		$4,490	
	Depreciation	1,200		5,875		7,125		1,660	
	Return on Investment	$-1,840		$-1,645		$-3,600		$2,830	
	Desirability Rating	-15		-1		-2		15	
COUNTY COURTHOUSE	I INVESTMENT								
	Installed Cost of Project	$ 12,000		$137,500		$150,000		$ 19,050	
	Investment Released or Avoided by Project								
	Net Investment Required	$ 12,000		$137,500		$150,000		$ 19,050	
	II OPERATING ADVANTAGE								
	DIRECT EFFECT OF PROJECT	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease
	Labor		$ 0		$6,350		$6,350		$5,385
	Maintenance	$ 60		$ 690		$ 750		$ 100	
	Materials and Supplies	90		1,030		1,125		150	
	Power	1,090		1,000		1,550		1,245	
	Floor Space		$ 600		$ 600		$ 600		$ 600
	Net Increase or Decrease in Operating Costs	$- 640			$4,230		$3,525		$4,490
	III COMPUTATION OF DESIRABILITY RATING								
	Total Advantage	$- 640		$ 4,230		$ 3,525		$4,490	
	Depreciation	1,200		5,875		7,125		1,660	
	Return on Investment	$-1,840		$-1,645		$-3,600		$2,830	
	Desirability Rating	-15		-1		-2		15	
HALL OF RECORDS	I INVESTMENT								
	Installed Cost of Project	$ 12,000		$141,100		$153,600		$ 22,650	
	Investment Released or Avoided by Project								
	Net Investment Required	$ 12,000		$141,100		$153,600		$ 22,650	
	II OPERATING ADVANTAGE								
	DIRECT EFFECT OF PROJECT	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease
	Labor		$ 0		$6,350		$6,350		$5,385
	Maintenance	$ 60		$ 690		$ 750		$ 100	
	Materials and Supplies	90		1,030		1,125		150	
	Power	1,090		1,000		1,550		1,245	
	Floor Space		$ 600		$ 600		$ 600		$ 600
	Net Increase or Decrease in Operating Costs	$- 640			$4,230		$3,525		$4,490
	III COMPUTATION OF DESIRABILITY RATING								
	Total Advantage	$- 640		$ 4,230		$ 3,525		$4,490	
	Depreciation	1,200		6,020		7,270		1,810	
	Return on Investment	$-1,840		$-1,790		$-3,745		$2,680	
	Desirability Rating	-15		-1		-2		12	
ENGINEERS BUILDING	I INVESTMENT								
	Installed Cost of Project	$ 12,000						$ 19,050	
	Investment Released or Avoided by Project								
	Net Investment Required	$ 12,000						$ 19,050	
	II OPERATING ADVANTAGE								
	DIRECT EFFECT OF PROJECT	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease
	Labor		$ 0						$5,385
	Maintenance	$ 60						$ 100	
	Materials and Supplies	90						150	
	Power	1,090						1,245	
	Floor Space		$ 600						$ 600
	Net Increase or Decrease in Operating Costs	$- 640							$4,490
	III COMPUTATION OF DESIRABILITY RATING								
	Total Advantage	$- 640						$4,490	
	Depreciation	1,200						1,660	
	Return on Investment	$-1,840						$2,830	
	Desirability Rating	-15						15	

Note: Term "Desirability Rating" is synonymous with percent of return on investment.

FIGURE VI-1 COMPARISON OF ECONOMIC DESIRABILITY OF SYSTEMS



*Systems 2 and 3 not applicable at Engineers Building

Summary:

In review of the foregoing evaluations of system modifications, Table VI-9 was prepared in summary of these findings, showing comparisons of system deficiencies, investment requirements and the increase or decrease in annual costs.

Based on investment requirements and the effect on annual costs of operation, basic interim improvements in these types of building systems could be accomplished most practically through the installation of stationary packers at slight additional annual cost. Installation of gravity chutes in existing buildings should be considered in future building modification plans.

It is likely that a pneumatic collection system and central processing station serving a number of buildings such as exist in the Civic Center complex could prove economically feasible, providing broad participation could be achieved. In the case of the Civic Center complex, this would likely require joint participation of Federal, State, County and City agencies occupying the numerous governmental buildings in the area and perhaps participation of private enterprise buildings on the perimeter of this complex. It is beyond the scope of this project to investigate such potentials further, but this concept is recommended for consideration in planned expansions of the Civic Center and in the planning stage of similar new complexes.

Comparison of Office Building Solid Waste Systems

TABLE VI-9 EFFECT OF SYSTEM MODIFICATIONS

	Hall of Records	Hall of Administration	County Courthouse	County Engineers
COMPARISON OF SYSTEM DEFICIENCIES				
Existing System	31%	41%	37%	42%
Considered System Modifications:				
System 1	24%	24%	24%	24%
System 2	20%	20%	20%	--
System 3	6%	6%	6%	--
System 4	24%	24%	24%	24%
EXISTING ANNUAL OPERATING COST	$ 65,385	$103,708	$ 70,617	$42,717
COSTS OF SYSTEM MODIFICATIONS:				
System 1 - Total Investment	$ 12,000	$ 12,000	$ 12,000	$12,000
*Annual Cost	1,840	1,840	1,840	1,840
System 2 - Total Investment	$137,500	$137,500	$141,100	--
*Annual Cost	1,645	1,645	1,790	--
System 3 - Total Investment	$150,000	$150,000	$153,600	--
*Annual Cost	3,600	3,600	3,745	--
System 4 - Total Investment	$ 19,050	$ 19,050	$ 22,650	$19,050
*Annual Cost	(2,830)	(2,830)	(2,680)	(2,830)

***Increase or decrease ( ) over annual operating costs of the existing solid waste system**, including annual depreciation expense for buildings and equipment, but, excluding interest expense and any additional off-site disposal costs that may be assessed.

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The findings of this study have confirmed general inadequacies that prevail, both in (1) the operation of conventional solid waste systems and (2) the development and/or use of hardware that can upgrade operating standards.

HOSPITAL WASTE SYSTEMS

In the hospitals inspected, both locally and throughout the country, significant deficiencies exist in the in-plant system as well as off-site disposal. Based on the detailed investigations of local institutions, those deficiencies, relating to the environmental aspects of in-plant handling and storage of wastes, are tolerated daily, while generally incurring high costs of operation. Mechanized and automated handling systems currently exist and are being tested and improved. Although relatively high in capital costs, these systems will likely provide overall economy in annual operating costs for many small and large institutions. Pneumatic conveyor systems for handling soiled linens and disposable wastes have the greatest potential for adaptation in existing buildings. The pneumatic system and conveyor systems for sealed container transfer both hold merit for use in buildings in the planning stage. The latter has the added flexibility of handling the distribution of clean supplies as well as soiled materials and wastes. However, it is also likely that economically the latter could not be justified unless it is in fact designed to handle all types of these materials. Both types of systems will afford similar improvements in operating standards in that material movements are accomplished in a closed transport system, minimizing exposure within the plant as well as minimizing interim storage requirements.

The deficiencies existing in on-site processing and disposal are largely due to lack of investment in proper equipment and/or operating personnel. However, types of equipment that can provide satisfactory processing are limited. Incineration is the only proven method of on-site disposal that is widely used. In many cases, on-site incinerators with reasonable capabilities are improperly operated. Similarly, many on-site installations exist that are not capable of handling the loads imposed on them or being operated to meet local standards, even if there were qualified operators. Both incinerator design and operation are highly complex. Although the importance of design engineering is now generally recognized, specialized training of operators is not. The industry is capable of designing incinerators to meet the most stringent standards. In the larger metropolitan areas where air pollution conditions are severe, the more sophisticated control devices will likely be required in order to meet local standards. However, it presently appears economically and/or technologically infeasible that such devices can be adapted to the smaller on-site incinerators based on lack of such equipment in this waiting market. Further, in view of the severity of air pollution conditions that exist in such areas as the Los Angeles Basin, where progressively restrictions are necessarily being strengthened on air pollution, incineration cannot be recommended. Except in such extreme cases, a properly designed incinerator with qualified operators is the only currently proven method of on-site disposal that could be recommended, whereby materials can be reduced and converted to an innocuous state, microbiologically safe for off-site transfer and disposal.

Alternative methods of on-site processing investigated that would properly condition waste materials were all centered around pulping or wet grinding. It was concluded that such processing, followed by sterilization and dewatering, would provide adequate conditioning for off-site transfer and disposal. Similarly, it was considered that the environment would not be further exposed to contamination if, following the pulping process, the material were discharged to the sewers, utilizing an already contaminated channel for transport. Various types of wet grinding and pulping equipment of various capacities are presently available and being improved. Such equipment can be sized for small and large installations. Sterilization processes and equipment specifically designed for handling of unselected solid wastes are non-existent. However, certain processes may be adapted for this need. Capabilities of the sewers for pipeline transport of additional non-settleable solids appear to be adequate if the materials are property introduced. Chief concern with this method, employing sewer transport, is the ultimate effect of solid loadings on conventional sewage treatment plants, water reclamation and modifications in treatment processes that may be required.

Considering the local conditions of the Los Angeles Basin area, and the dilemma facing the hundreds of hospitals, nursing homes, clinics, etc., all generating similar wastes and having similar problems in the control of processing and disposal of these materials, the need for detailed studies of pulping and wet grinding was considered warranted. This study appeared fully justified when considering that improving standards of handling and disposal of hospital wastes is a growing national problem.

Further development of this concept suggested that a pilot project be developed of sufficient scale to prove meaningful under a wide range of conditions. Inasmuch as successful experimentations have been carried out on small scale projects, it is vital that this project be of sufficient scope to test the full range of disposal methods connected with the wet grinding or pulping process.

Based on these qualifications and the total findings of this study, the project concept was further developed, and the LAC-USC Medical Center was recommended as the site for this project. Complete details of the development of this concept, together with schematic plans, and the environmental and economic evaluation of the modified system for the Medical Center, were carried out in Volume IV and are appended (Appendix G) in their entirety in this volume for the reader's convenience.

The proposed project includes the design, construction and operation of the proposed waste system, together with an extensive program of observations, analysis, and testing (as noted in the appended study).

The proposed system for this project involves pneumatic transport of disposable wastes and reusable linens employing a single tube pneumatic conveyor system. This proposed system also will contain a central pulping station for disposable materials, a wet oxidation process and an experimental sewage treatment plant. Optional disposal methods available include discharge of raw or sterilized pulped wastes to sewers, transport of dewatered raw or sterilized pulped wastes to landfills, nearly complete oxidation of pulped wastes with discharge of residue to sewers or dewatered residue to landfills or emergency bypassing of all processes with direct discharge of bulk wastes to a compactor for disposal at landfills.

Based upon the foregoing study, this project is recommended as a solution to the more critical problems of the current solid waste system at LAC-USC Medical Center. It is a solution with qualifying economic and environmental benefits. In summation, the proposed project would meet local needs while also providing a laboratory for study and experimentation on a number of optional disposal methods for institutional application.

DETENTION FACILITY WASTE SYSTEMS

The observation and evaluation of existing solid waste systems in local detention facilities indicated that principal in-plant deficiencies occur in central storage. Manual in-plant housekeeping functions, including the collection and transfer of solid wastes to central storage, are generally performed by inmate work details. Changes in the manner of performance of these internal functions are not considered feasible and quality of such performance is subject to the enforcement of standards by staff and supervisors.

Mechanization of any portion of the solid waste system, subject to abuse by inmate operators, should be avoided. Although mechanical processing devices such as stationary compactors would improve central storage conditions, reliable functioning could be expected only if operated and maintained by a qualified employee. As a practical matter, improvements in detention facility waste systems can be expected only through enforcement of standards by staff and supervisors.

OFFICE BUILDING WASTE SYSTEMS

In those office buildings investigated in the Civic Center, only minor deficiencies were found in the elements of storage and off-site disposal. Generally, in-plant supervision is effective in maintaining good operating standards. In-plant deficiencies that occur are primarily due to lack of equipment for confinement and reduction of collected waste materials.

Interim improvements in these systems will require adoption of higher standards of operation with accompanying increase in annual costs. Basic improvements can be accomplished with the installation of manually fed stationary compactor units. Further improvements can be accomplished with chute installations directly feeding the compactor units.

Long range improvements, involving chute installations in each building connected with a central pneumatic conveyor system and processing station, should be considered in planned expansions in the Civic Center complex in the initial design stages of similar projects.

The proposed project recommended for the LAC-USC Medical Center will determine the feasibility of such systems and the results should also be evaluated from the viewpoint of application to office building complexes.

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APPENDICES

The study and evaluation of the existing solid waste system operation at the LAC-USC Medical Center, as reported in Chapter II, Volume II, is appended in its entirety. This study illustrates the depth of investigations undertaken and supports the continuing studies of this institution leading to recommended system modifications.

CHAP. II LAC-USC MEDICAL CENTER

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LIST OF FIGURES

DESCRIPTION OF EXISTING PLANT

Los Angeles County-University of Southern California Medical Center, until 1968 known as Los Angeles County General Hospital, is the largest facility of the eight hospitals presently operated by the Los Angeles County Department of Hospitals and one of the largest facilities in the United States. Through its affiliation with USC Medical School, it is also one of the largest teaching hospitals in the country. The Medical Center, along with the other County hospitals, is administered by the Board of Supervisors through the Director of the Department of Hospitals. However, at plant management level, each of these hospital facilities may be considered autonomous or semi-autonomous in the adoption and implementation of administrative policies and plant operating procedures.

Range of Medical Functions and Specialties:

The Medical Center is operated to provide hospitalization, out-patient care and convalescent care as well as home care for qualifying patients within certain geographic limits of Los Angeles County and the maximum capacity limits of its facilities. It offers specialized diagnostic, medical and surgical procedures as well as emergency care for the critically ill and accident victims. It provides teaching and training programs for medical specialties, nursing and allied health professions, including clinical teaching to USC students and post-graduate training for health personnel through its affiliation with the University, as well as inservice training for both health and supportive personnel. It actively supports research efforts to advance medical knowledge, treatment techniques, health services and management functions, all in cooperation with the University.

Types of care offered include preventive, diagnostic and therapeutic functions. Plant facilities provide for inpatient, outpatient and emergency services. A comprehensive range of medical care specialties, or special categories, are provided including:

Internal Medicine	Pediatrics	Burns
Chest Medicine	Communicable Diseases	Neurosurgical
Dermatology	Psychiatry	Orthopedics
Metabolic Unit	Jail Medicine	Otolaryngology
Renal	General Surgery	Ophthalmology
Dentistry	Chest Surgery	Urology
Neuromedicine	Tumor	Premature Center
	Obstetrics/Gynecology	

Plant Services and Population Related to Solid Waste Production:

Present plant services maintained at this facility and staffed by hospital personnel include the Dietary Department, which prepares some 10,000 meals daily, the Laundry, which processes some 56,500 pounds of soiled linen daily with a working staff of 200, General Services (Housekeeping and Custodial Services) with a staff of 600, the Transportation Department, Maintenance Shops, Security, Pharmacy.

The Business Office, Medical Records, Personnel, Communications and the Computer Center provide those business services required in further support of the plant activities. A nursing staff of 1,466 and 3,181 nurses aides (attendants) are involved in the various aspects of patient care functions.

Total population in the Medical Center Complex is comparable to that of a substantial community. Including patients, paid and non-compensated personnel, there is a gross population of approximately 21,000 persons scheduled over a seven-day week, 24-hour day basis. Non-compensated personnel include students, trainees, volunteer workers and personnel that may be paid by other agencies.

The breakdown of the total population based on daily census records and ordinance personnel lists consists of about 2,000 bed patients per day (avg. seven-day basis), 2,800 outpatients per day (avg. five-day basis), 10,800 paid personnel and 5,600 non-compensated personnel.

Each person in this total population of 21,000 is a direct creator of solid waste, and quantities of wastes each generates varies with his classification, daily activities and hours present.

Table II-1 illustrates probable variations in plant population that may occur over the weekly period and relates the corresponding rate (percentage) of waste production by shifts that may be expected daily.

TABLE II-1 SHIFT POPULATION AND WASTE PRODUCTION

	Monday - Friday			Saturday and Sunday		
	1st Shift	2nd Shift	3rd Shift	1st Shift	2nd Shift	3rd Shift
Bed Patients (constant)	2,000	2,000	2,000	2,000	2,000	2,000
Outpatients	2,800	---	---	---	---	---
Paid Personnel	5,400	1,500	1,500	3,000	1,500	1,500
Non-Comp. Personnel	3,200	1,600	800	---	---	---
Total Est. Population/Shift	13,400	5,100	4,300	5,000	3,500	3,500
Avg. Shift & Daily Pop.	*7,100			4,000		
Rate of Waste Production: % of Daily Production	54%	25%	21%	42%	29%	29%

*Includes outpatients weighted at 1/2 value due to limited time in hospital

Although the above estimate and observations indicate that waste production is a continuing process, the major handling of accumulated wastes is primarily confined to services provided during the first shift operation.

Location, Buildings and Land:

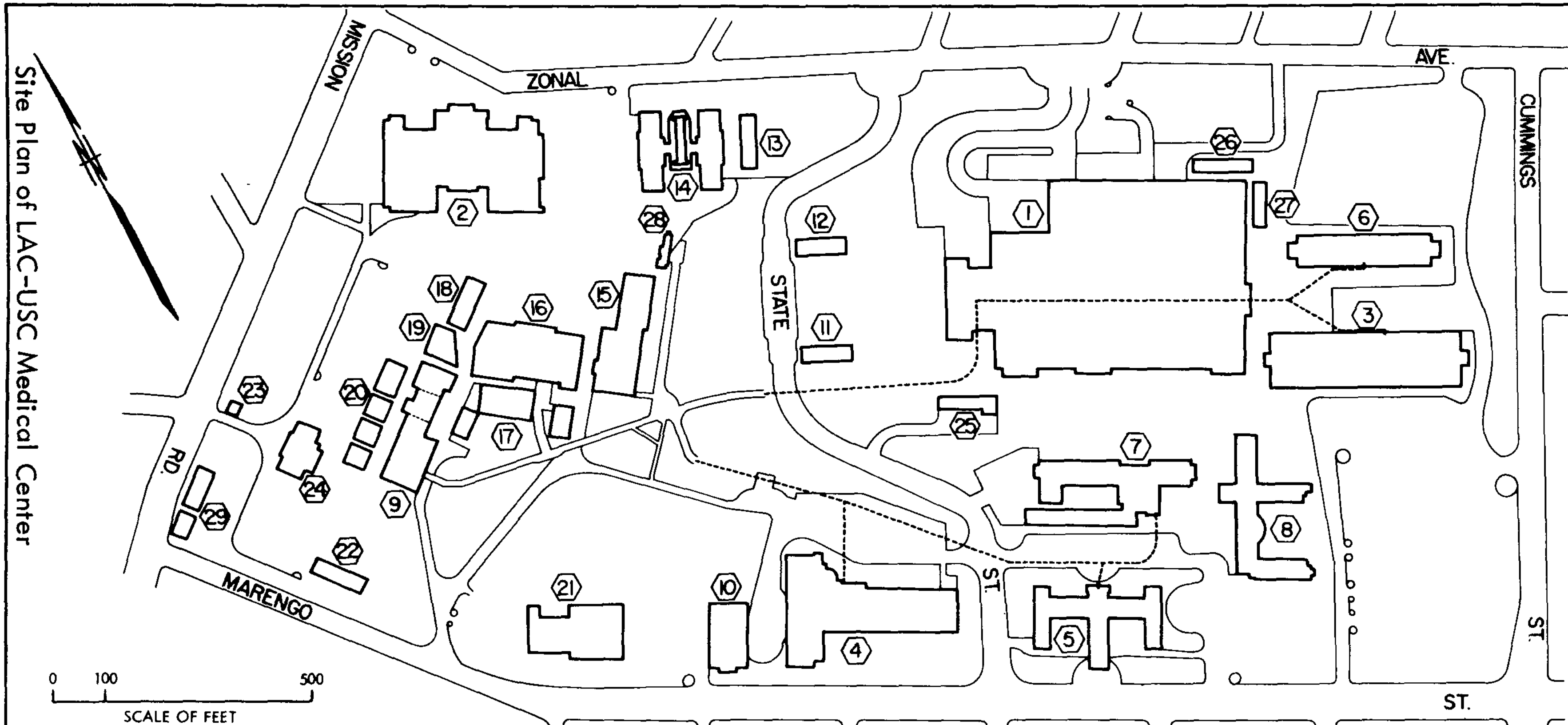
The Medical Center is located in the Central District of Los Angeles about one mile northeast of the downtown Civic Center. Bounded by Mission Street, Marengo Avenue, Cummings Street and Zonal Avenue, it occupies a site of some 68 acres bisected by State Street meandering on a north-south axis through this property. The proportions of the property range from about 1200 feet wide on the north-south axis to an average length of some 2500 feet. Grade differential is considerable, ranging from the highest elevation on the east boundary (Cummings Street) at 430' MSL, falling about 125' in grade to the west with its lowest elevation at about 305' in the southwest portion of the property.

Basically, the total site consists of three building plateaus. Nominal differences in grade will be found in that portion of the property developed as building sites and parking areas lying west of State Street with grades ranging from the low of 305' to 337'. The developed building areas generally lying in the southeast quarter of the property, east of State Street, range from a low of 330' to a high of 350'. In the northeast quarter, also lying east of State Street, grades range from a nominal low of 360' to 400', with abrupt changes of grade occurring along the west and south borders of this parcel.

This complex is comprised of 28 buildings, varying from 1 to 20 stories in height. Nineteen of these buildings are classified as permanent structures. The remaining nine buildings, though classified as obsolete, are currently in use.

The Site Plan of the existing plant, Figure II-1, identifies all buildings by number, function, number of stories, etc. The aerial photograph, Figure II-2, further illustrates the relationship of buildings and emphasizes the magnitude of this complex. Future development by the addition of major new buildings will likely be confined to the general area presently occupied by these obsolete structures. Buildings in this complex, ranging from 5 to 40 years in age, together with land, equipment and vehicles, are estimated to have a replacement value of approximately $150,000,000. Collectively, the existing buildings provide about 3,000,000 square feet of useable floor area, of which some 2,800,000 square feet is represented in permanent structures.

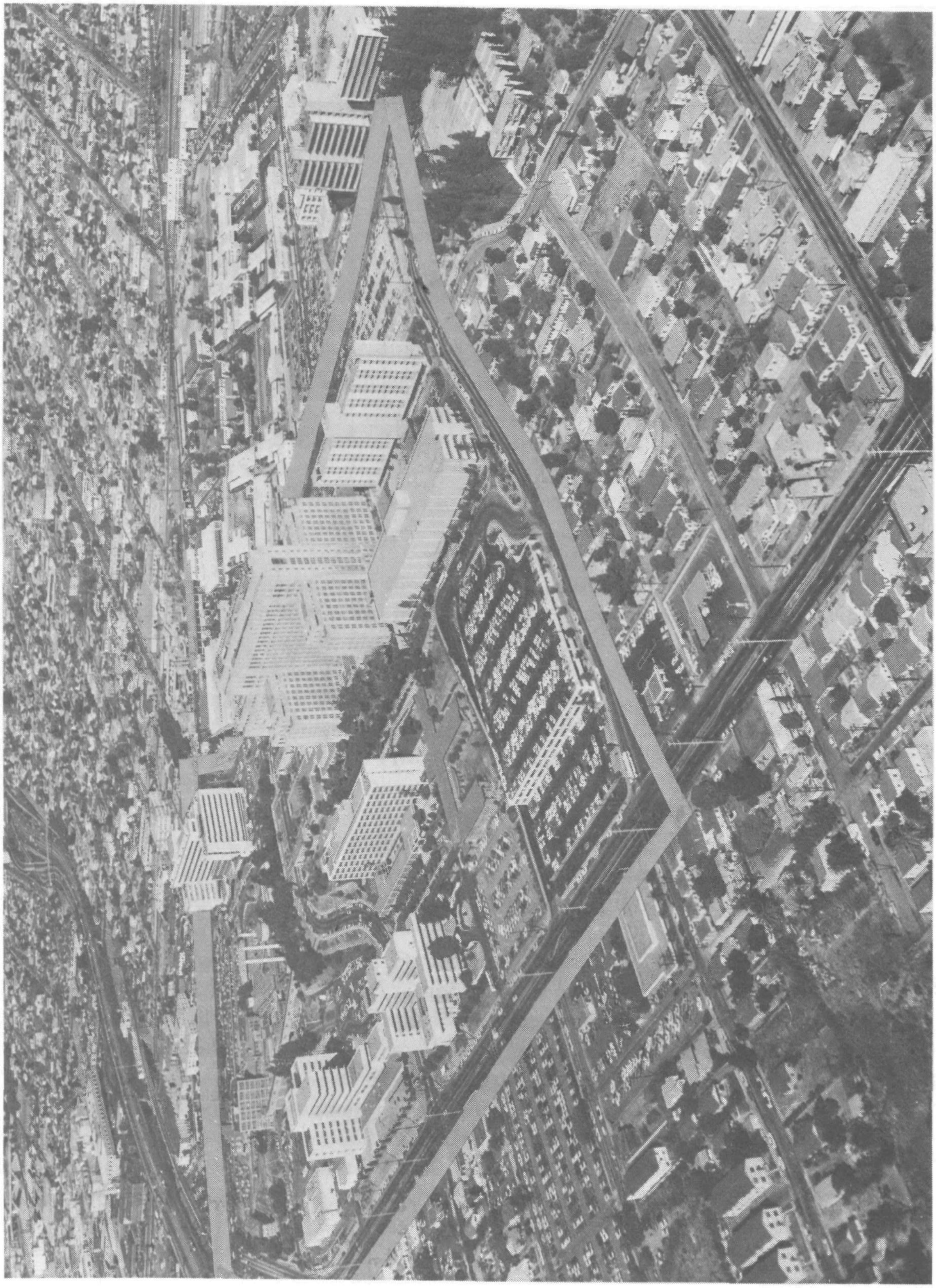
Site Plan of LAC-USC Medical Center



BUILDING SCHEDULE

Bldg. No.	Function	No. Floors	Area (SF)	Bldg. No.	Function	No. Floors	Area (SF)	Bldg. No.	Function	No. Floors	Area (SF)	Bldg. No.	Function	No. Floors	Area (SF)
1	Unit I - Acute	19	1,285,000	9	Pharmacy	6	55,000	16	Laundry	2	55,200	23	Gate House	1	2,400
2	Unit II - O.B. & Gyn.	9	376,110	10	General Laboratory	3	33,000	17	Shops	1	12,200	24	Admin. (Hosp. Dept.)	4	30,600
3	Outpatients	4	209,000	11	Chaplain	1	2,750	18	Research Building	3	14,500	25	Telephone Exchange	2	6,180
4	Pediatrics & C.D.	8	171,075	12	Patient Identification	1	2,725	19	Garage	2	6,160	26	Storage	1	2,940
5	Psychiatric	9	132,000	13	Research Building	1	22,000	20	Storage	1	4,100	27	Storage	1	2,270
6	Interns Residence	10	139,000	14	Clinical Research	4	61,000	21	Steam Plant	-	--	28	Incinerator	-	--
7	Nurses Res. & Classrooms	9	171,620	15	Power House	-	--	22	Cancer Research	2	10,200	29	Classrooms	1	2,000
8	Nurses Residence	2	46,000												

FIGURE II-1



Aerial Photograph of LAC-USC Medical Center

FIGURE II-2

CHARACTERISTICS OF THE SOLID WASTE SYSTEM

The foregoing description of the existing facilities at the Medical Center has indicated the complexities of this 68-acre plant layout. The complexities of the total solid waste system, both in variety of materials generated and methods of handling, processing and disposal of these materials, are equally as great.

Types of Waste Materials Generated:

Types of conventional solid wastes generated in this plant present similar varieties and quantities as will be found in a municipality of similar size, including:

1. Garbage
2. Rubbish
3. Ashes
4. Dead Animals
5. Special Wastes
6. Bulky Wastes (furnishings, auto parts, tires, etc.)
7. Expended Vehicles
8. Street and Landscaping Refuse
9. Construction and Demolition Wastes
10. Industrial Wastes (shops)

In addition, reusable materials and equipment, such as linens, food service items, patient care items, etc. requiring reprocessing, will be found in quantities that far exceed the amounts of these conventional solid wastes. These reusables have all the handling and transport problems of conventional waste materials, and dependent on future changes in operating policy, single-use (disposable) items may replace certain of these materials, substantially increasing the problem of disposal.

Generally, bulky wastes, worn-out vehicles, street and landscaping refuse, construction and demolition wastes are handled in separate channels apart from the main flow of waste materials generated daily within the plant buildings. Daily quantities of these materials generated fluctuate considerably. Dependent on the nature and quality of these materials, they may be salvaged for in-plant reuse or deposited at landfills. By and large, the methods of disposal selected appear to be satisfactory and are limited by the characteristics of the individual waste materials. Detailed studies of these types of wastes will not be considered further in this study, except as they may be found within the building waste handling system. Similarly, those radiological wastes which are generated in varying quantities and handled in compliance with State and Federal regulations will not be investigated in depth except as they may affect the waste handling system in this building complex.

In summary, the identification of kinds of wastes that may be found in the main stream of the solid waste system include garbage, rubbish, ashes, dead animals, special wastes and reusables. From observations of the different characteristics of certain waste materials and their respective handling requirements within the total system, eight categories of waste materials have been established for detailed study. These categories are identified as follows:

1. Sharps - needles, blades, etc. (Disposable)
2. Surgical, pathological and animals (Disposable)
3. Soiled linen (Reusable)
4. Rubbish or mixed refuse (Disposable)
5. Patient care items (Reusable)
6. Non-combustible - glass, metals and ashes (Disposable)
7. Garbage (Non-grindable) (Disposable)
8. Food service items (Reusable)

Brief Description of the Total System:

Policies of operation of the solid waste system specify relatively direct and simple procedures to be followed. Certain special purpose equipment has been provided for disposal of wastes. Pathologic incinerators provide facilities for disposal of tissue wastes. Grinder installations provide facilities for disposal of food preparation wastes and selected pathologic wastes. Central on-site incineration has generally prevailed over the years for the disposal of other infectious wastes. The balance of disposable wastes are hauled by hospital packer trucks to landfill for final disposal.

An inter-building transfer system, employing tram trains, collects loaded carts at intermediate storage points, transports them via surface, tunnel and corridor routes to central storage points. Infectious wastes are discharged at the central incinerator for disposal. Other disposable wastes are discharged and loaded into a compactor truck for transport to a landfill. Reusable wastes are directed to their respective reprocessing points. The compactor truck also provides collection service from a number of outlying buildings not serviced by the tram train. Direct haul to the landfill is made after each load is collected.

Various methods of waste collection and transport exist within the 28 buildings in this complex. However, generally hand cart collection of materials on each floor prevails. Eight of the multistory buildings have chutes for vertical transport of soiled linens and mixed refuse. The balance of waste materials, both reusables and disposables, are transported by elevators where available or manually via stairs in some of the two and three story buildings to intermediate storage points to await the inter-building pickup.

Responsibility of Solid Waste Management:

General Services (Housekeeping and Custodial Services) is charged with the responsibility of solid waste management along with other plant services. In performance of the functions in solid waste management, this department must observe those general regulations dealing with building safety, fire prevention, air pollution, sanitation, as well as the applicable requirements of the Hospital Licensing Act.

Operational policies have been adopted by plant administration which provide a means of coordinating all supportive services with the medical activities within the plant. Coordination between the Medical Department, charged with the primary function of patient care services, and the Non-Medical Departments' function of providing all other required support services is accomplished through a system which subdivides the total plant operation into administrative or service areas. Each area is assigned an administrator to provide liaison between Medical and Non-Medical personnel in performance of their respective functions.

As related to management of the solid waste system by Housekeeping and Custodial Services, these service areas may be physically defined as follows:

Area 1 - The Outpatient and Admitting Room Administrative Area, consisting of the Outpatient Building (Bldg. No. 3) and the basement and 1st floor of Unit I (Bldg. No. 1).

Area 2 - The Laboratory-Radiology and Surgical Specialties Administrative Areas, consisting of floors 2, 3, 4 and 5 of Unit I (Bldg. No. 1).

Area 3 - The General Medicine Administrative Area, consisting of floors 6, 7 and 8 of Unit I (Bldg. No. 1).

Area 4 - The Medical-Surgical Administrative Area, consisting of floors 9 through 19 of Unit I (Bldg. No. 1).

Area 5 - Psychiatry and Children's Division Administrative Areas, consisting of the Psychiatric Building (Bldg. No. 5) and the Children's Division Building (Bldg. No. 4).

Area 6 - The Obstetrics-Gynecology Administrative Area, consisting of Unit II (Bldg. No. 2).

Two other service areas generally non-medical in function are defined as follows:

Area 7 - The Special Services Area, consisting of all outlying buildings (Bldgs. No. 9 through 28), grounds, service yards and tunnels.

Area 8 - The Resident Hall Area, consisting of the Interns and Nurses Buildings (Bldgs. Nos. 6, 7 and 8).

Organization of Manpower:

The housekeeping and custodial labor force is subdivided into teams serving the total plant. These teams provide all services for the specified service areas, including on-floor refuse collection activities and transport of segregated waste material to intermediate storage points.

A special service team (for Area 7) provides all custodial services to the group of outlying buildings, as well as operation of tram trains, elevators and refuse trucks for transfer of waste materials from intermediate storage areas in all buildings to central storage, processing and disposal points.

Personnel of other departments are involved in certain aspects of handling soiled linen and used food service items. The nursing staff and aides are largely responsible for on-floor handling up to the point of depositing linens in the laundry chutes and placing used food service items on the carts for return. Laundry personnel are assigned to clean out the soiled linen chute rooms, including bagging and placing on soiled linen carts. Dietary personnel, of course, handle cleanup of food carts on the return to the kitchen.

Each of the eight service areas are staffed to furnish services as required on a seven-day week basis. Table II-2 indicates General Services manpower classifications and assignments in each of these areas.

TABLE II-2 GENERAL SERVICES PERSONNEL

Personnel Classification	Personnel Assigned by Service Areas 1	2	3	4	5	6	7	8	Total
Sr. Foreman	1	1	1	1	1	1	1	-	7
Cust. Foreman	2	2	2	2	2	3	2	-	15
Cust. Working Foreman	3	3	3	4	3	4	-	-	20
Institutional Laborers	7	-	-	-	3	2	9	-	21
Custodians	74	51	44	61	64	80	43	10	427
Truck Driver	-	-	-	-	-	-	3	-	3
Tram Operator	-	-	-	-	-	-	6	-	6
Elev. Operator	-	-	-	-	-	-	36	-	36
Chief Hskpr.	-	-	-	-	-	-	-	1	1
Sr. Hskpr.	-	-	-	-	-	-	-	2	2
Housekeepers	-	-	-	-	-	-	-	48	48
Misc.	-	-	-	-	-	-	18	-	18
Total	87	57	50	68	73	90	118	61	604

OBSERVATIONS OF THE INTER-BUILDING AND OFF-SITE SYSTEM

Comprehensive field observations were conducted during October, November and December, 1968, at the Medical Center to determine (1) daily quantities of solid wastes produced, (2) distribution of generated wastes by principal buildings and/or accumulation points, (3) manpower, and equipment used in the handling and disposal of these materials, and (4) actual methods and practices employed.

Initial inspections at the Medical Center were made to identify the characteristics and functions of the inter-building solid waste system. Upon inspection of the complexities of the inter-building material handling system in which solid wastes were transported, it appeared that extended observations were warranted in this area.

The Inter-Building Materials Handling System:

Ten major buildings of the plant are connected by a combination of elevated corridors, tunnels, basement corridors and surface lanes providing the basic traffic network for inter-building movement of pedestrians and materials. The remaining 18 buildings are served primarily by surface routes (streets and sidewalks).

The tunnel-corridor network serving the major buildings is the common transport route for the movement of pedestrian traffic (employees and patients), clean materials and dirty materials. Various types of small vehicles (combustion engines and electric powered vehicles) are utilized in this activity. Peak activities in movement of materials and people generally occur at different time intervals; however, overlapping of these functions is common in a routine day. Peak pedestrian movements occur with changes of shifts. Peak activities in movement of clean materials occur with the dispatch of pharmacy supplies, clean linen supplies, food cart movement prior to meal service, and distribution and collection of medical records. Peak activities in movement of dirty materials occur with refuse and soiled linen collection, return of food carts following meal service, and return of reusable equipment associated with patient care. During these peak periods, moderate traffic congestion is noticeable at the terminal (distribution and collection) points in each of the buildings along the tunnel-corridor network.

The center of material handling activity and the major area of congestion exists in the corridors of Unit I wherein trains of food carts, medical records and general supplies are assembled for dispatch and disassembled on return. Through traffic of clean and dirty materials routed to and from the Interns' Residence and Outpatient Clinic must pass through the main corridor. Cleanout of soiled linen and trash rooms adjacent to this corridor and makeup of the carts and trains handling this material generated in Unit I also occurs here. Nearly all general supplies for upper floors of Unit I must be dispatched from this corridor level. Patients being transferred for treatment to Unit I or the Outpatient Clinic must also be moved through the main corridor. The interchange of plant personnel between buildings and working personnel in various departments on the service level of Unit I is a continuing process as required by the daily routine. Due to inadequate warehousing space, corridors are used as an area for overflow storage of new supplies and equipment until permanent storage space becomes available. Substantial congestion is the prevailing condition in the main corridor of Unit I from 6:00 a.m. to 2:00 p.m., when pedestrian and material movements slack off.

Extreme congestion of cart traffic at variable intervals also occurs at both the laundry receiving area and the central storage area for refuse (former incinerator) with carts often backed up into the adjacent areas of the tunnel-corridor awaiting unloading or return.

To measure the magnitude of the inter-building materials handling system, observations of the tram train activity over a two day period were recorded. Average daily activity of the three tram trains used in the system was calculated at a combined total of 193 stops for pickup and/or discharge of carts, with a total of 493 cart movements occurring daily. These observations were confined to a ten-hour period during the day and did not include activity after 3:00 p.m., which principally consists of food cart movements for the evening meal and other limited activity. These observations also excluded the tram train assigned exclusively for the movement of pharmacy supplies and other vehicles used in material and people movement. Figures II-3 and 4 were prepared to illustrate hourly activity during the ten hour period and the percentage of activity related to the movement of clean and dirty materials. Including the return movement of food carts, together with soiled linen cart and refuse cart movements, 63% of pickups, 68% of cart movements and 63% of daily time were allocated to solid waste handling.

FIGURE II-3 OBSERVATIONS OF DAILY CART MOVEMENT

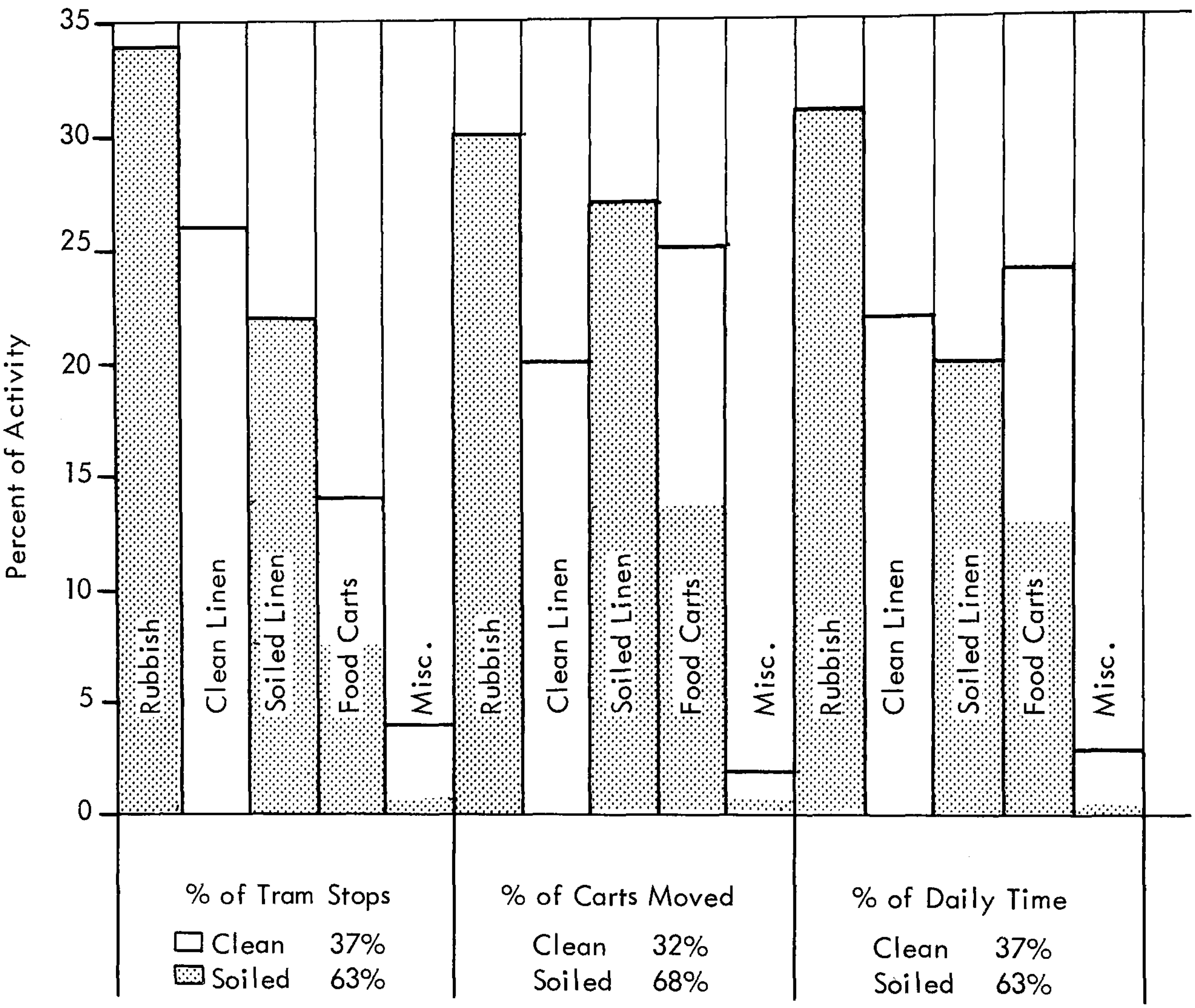


FIGURE II-4 DETAIL OF CLEAN AND SOILED CART MOVEMENTS

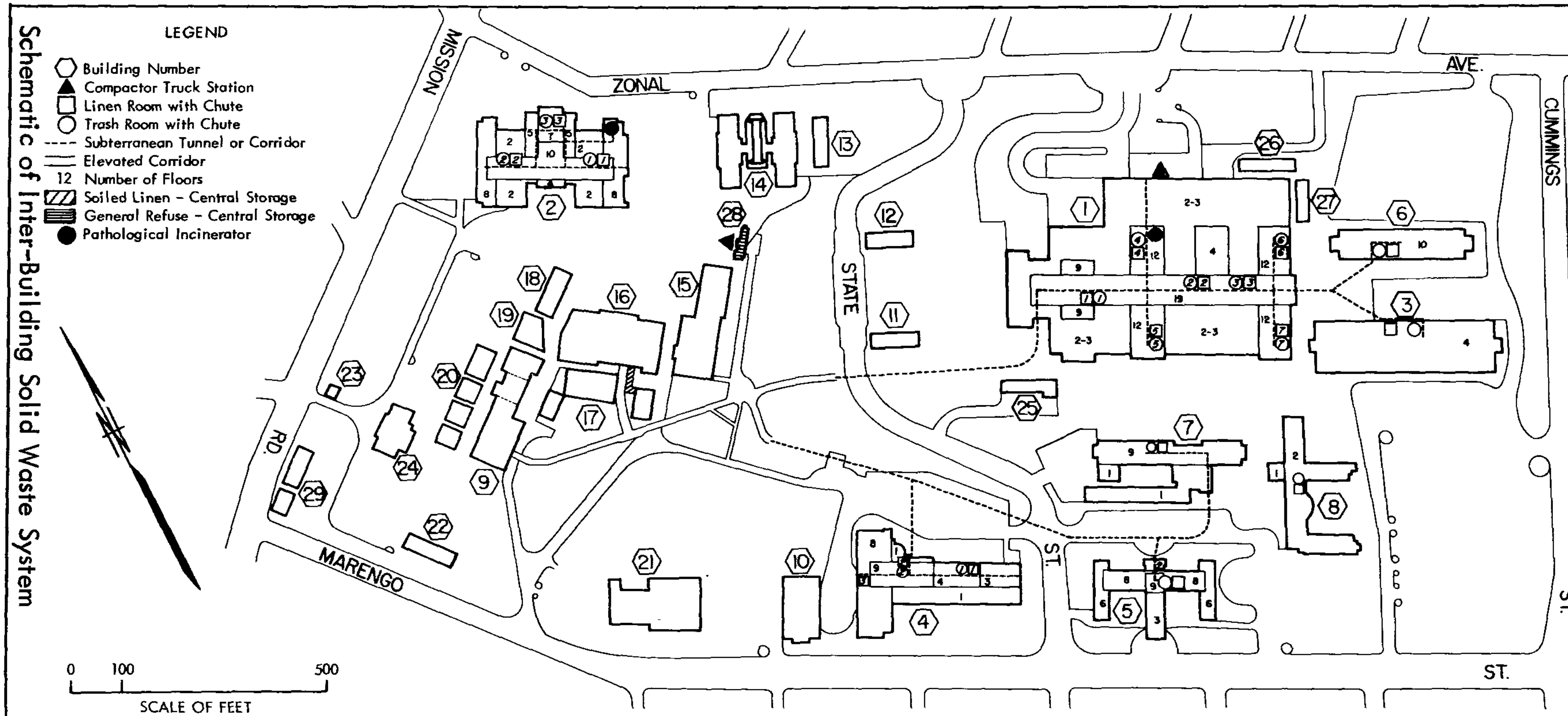
Handling and Storage of Disposable Waste Materials:

Figure II-5 illustrates the building layout of this plant and shows the location of the connecting tunnel-corridor network, intermediate and central solid waste storage points, as well as collection stations serving the minor buildings. It will be noted that nine buildings in this complex, varying from 3 to 20 stories in height, collectively contain 18 intermediate trash and soiled linen storage rooms, each being chute fed from the floors above. Other intermediate storage points include the "can room" and "tank carts" in the kitchen area in Unit I. In addition to these principal waste storage points, some 30 refuse collection stations (cans and bins) are located on surface routes throughout the complex.

In each of the trash rooms, a portable bin (cart) of about 2 to 2 1/2 cubic yard capacity with hinged top is positioned to receive the direct discharge from the trash chutes. It is intended that as these carts are filled to capacity, an empty cart will be manually moved into position. Often in practice, this cart movement does not occur until the loaded cart is overflowing and/or the chute is backed up. When these circumstances develop, manual clearing of the chute and cleanup of spilled litter is required. Observations indicate the majority of this mixed refuse is plastic bagged before deposit in the chutes. However, rupturing of bags occurs along with occasional deposits of loose material directly into the chutes. An intermix of reusable equipment items, such as soiled linen, patient care utensils, etc. is commonplace. These salvageable pieces are normally separated when observed and re-channeled into their proper route for reprocessing. As carts are filled during the day, they are moved out of the trash rooms into the adjoining corridors to await pickup by the tram train and transport to the central storage area. Here the carts are uncoupled to await discharge of contents, and are returned to assigned or needed locations on subsequent trips.

Segregated non-combustibles, disposable syringes and needles, and all pathologic wastes are collected in covered containers, then transported via hand cart and elevator to the "can room" located on a branch of the main service level corridor in Unit I. Here materials are assembled for later disposition. The intended systems direct that all materials other than segregated pathologic wastes be loaded on flat bed carts for transport to the central storage area to await disposal. Pathologic wastes are either directed to the pathologic incinerator in Unit I or in Unit II.

Schematic of Inter-Building Solid Waste System



BUILDING SCHEDULE

Bldg. No.	Function	No. Floors	Area (SF)
1	Unit I - Acute	19	1,285,000
2	Unit II - O.B. & Gyn.	9	376,110
3	Outpatients	4	209,000
4	Pediatrics & C.D.	8	171,075
5	Psychiatric	9	132,000
6	Interns Residence	10	139,000
7	Nurses Res. & Classrooms	9	171,620
8	Nurses Residence	2	46,000
9	Pharmacy	6	55,000
10	General Laboratory	3	33,000
11	Chaplain	1	2,750
12	Patient Identification	1	2,725
13	Research Building	1	22,000
14	Clinical Research	4	61,000
15	Power House	-	--
16	Laundry	2	55,200
17	Shops	1	12,200
18	Research Building	3	14,500
19	Garage	2	6,160
20	Storage	1	4,100
21	Steam Plant	-	--
22	Cancer Research	2	10,200
23	Gate House	1	2,400
24	Admin. (Hosp. Dept.)	4	30,600
25	Telephone Exchange	2	6,180
26	Storage	1	2,940
27	Storage	1	2,270
28	Incinerator	-	--
29	Classrooms	1	2,000

FIGURE II-5

Non-grindable wastes from the kitchen are deposited in "tank carts". These carts are transferred from the ground floor kitchen to the basement level by elevator to await pickup by the tram train and transport to the central storage area.

Waste Disposal Practices:

At the beginning of the observation period, on-site disposal of the majority of mixed refuse was accomplished by incineration. However, during this period, the incinerator installation, due to violation of air pollution regulations, was forced to shut down, and all waste materials formerly handled by this method were routed to a privately operated landfill via the hospital's compactor truck. During the time incineration was practiced, the carts containing mixed refuse, kitchen wastes, etc. were emptied directly on the upper level charging floor of the incinerator, then scooped (charged) into the furnace in a continuous manner until the capacity of the furnace was reached. Segregated non-combustible materials and accumulations of disposable syringes and needles in cans were stored for later transfer to the landfill.

After incineration was discontinued, an improvised plywood chute was constructed to convey all waste materials from the upper level charging floor to a rear end loader compactor truck on a parking lot grade some 14 feet below. Generally an attempt was made to discharge the carts directly into the chute or in its vicinity. Problems of area littering and sanitation on the charging floor level were similar for both the incineration operation and the truck loading operation; however, the latter method also created additional problems in the area of the truck at ground level. This system was later modified when a new top loading (forklift) truck was acquired. Present methods provide direct chute discharge to the topside receiving hopper of the truck. Spillage has been minimized in the loading operation but windblown littering as well as occasional overcharging of the chute remains a sanitation problem. A second rear loading compactor truck utilized in the plant system is normally stationed at the loading dock at the service level on the north side of Unit I. This loading dock is also utilized as a principal receiving point for incoming supplies. All bulky packaging materials from the warehousing operation and miscellaneous other wastes are loaded directly into this truck during the day. This truck is also employed on a building to building collection system servicing the balance of the outlying buildings in this complex. Due to the nature of this collection system, this truck proceeds to a private landfill for disposal of all materials as loads are collected. Currently (since October, 1968), all wastes formerly incinerated are also hauled to the same landfill for disposal. Observations at this landfill indicate substantial salvage activities occur on a continuing basis at the working faces of the fill. Hospital wastes are routinely handled at discharge points common to all refuse haulers.

At the time of observations, the pathologic incinerator in Unit II was partially disassembled for repairs and the incinerator in Unit I was not used due to malfunction. After the central incinerator was shut down, no alternate method of on-site disposal existed for this material. Due to apparent lack of communications or lack of an awareness of the problem, these materials were inadvertently channeled into the off-site disposal channel by operating personnel. It may be pointed out at this time that the location of the pathologic incinerator in Unit I is at an intermediate level between the basement and the ground floor level. All wastes intended to be handled by this incinerator must be transported to the basement level by hand cart and elevator, and then hand carried up two flights of stairs to the incinerator cubicle. Similarly all residue must be hand carried to the basement level.

Handling and Storage of Reusable Waste Materials:

The routine in handling soiled linen is similar to the methods of handling mixed refuse. The majority of linen gathered on floors is either bagged (cloth) or bundled before deposit in the chutes. Observations at the chute rooms indicate a substantial quantity of the bagged material loosens and scatters on impact and that a sizeable quantity, principally surgical linen, is placed in the chutes in a loose form. As in the case of the trash rooms, a miscellaneous intermix of other reusable materials, as well as rubbish, may be found in the soiled linen rooms. Cleaning out linen rooms involves separation of the extraneous items, rebagging and loading the linen on flatbed soiled linen carts. These are placed in the adjoining corridor to await pickup by the tram train and transport to the receiving area adjacent to the laundry. These materials are either taken directly from the cart to a conveyor belt for manual sorting or unloaded on the nearby soiled stockpile to await the sorting process. At peak activities, soiled linen carts are backed up well into the elevated corridor awaiting handling. At times, assembled clean linen supply carts awaiting tram train distribution further congest this area.

The major reusable material other than linen at this facility generally consists of patient care and food service items, etc. After use, those materials leaving the floors above are transported via cart and elevator to intermediate collection points on the service level to await pickup by the tram trains for transport to their respective stations for reprocessing. However, in the case of patient care utensils, the cleaning process may occur on the floor or at central sterilization stations within the building, not requiring tram train handling. Reusable food service items are, of course, returned on the food carts to the central kitchen cleaning area in Unit I.

Quantities and Types of Disposable Waste Materials:

After identification of methods and practices characteristic of the systems operation, a quantity survey was made to determine daily volume of solid wastes produced in the total plant.

Initially observations were limited to that portion of wastes transported via the tram train to the incinerator which at that time was in operation. Portable scales were located in the vicinity of the incinerator, and a record was prepared identifying all carts by number, tare weight and locations (building, trash room, etc.) where specific carts were assigned. Similarly all accumulation or intermediate storage points were identified by building location. Actual weighing of loaded carts was recorded for a period of eight days to acquire a reasonable cross section of daily activity and to establish a "typical" day's production as delivered to the incinerator. Considerable variations in quantities collected were observed during this period. Observers' comments indicate this was likely due to the variable productivity of labor and/or mechanical problems rather than extreme variations in waste production during the normal week day. However, with limited activity of administrative, outpatient, laboratory and other supportive functions during the weekend, it is obvious that waste production would also be substantially lower during the weekend period.

Tables II-3 and II-4 illustrate typical daily activity occurring during this eight day period in refuse cart movements, distribution of wastes by accumulation points and buildings within the plant, and the breakdown of segregated non-combustible and mixed refuse as delivered to the incinerator area. These summaries do not include the quantities of wastes collected by the compactor truck for landfill disposal.

TABLE II-3 INTER-BUILDING DISPOSABLE WASTE COLLECTION

Date	Disposable Solid Wastes Transferred					Cart Movement	
	Combustible		Non-Comb.		Total (Lbs.)	No./Day	Avg. Net Wt. Lbs./Cart
	Lbs.	% Tot.	Lbs.	% Tot.			
10-16 (W)	10,673	93.3	750	6.7	11,423	84	136
10-17 (Th)	9,828	94.3	590	5.7	10,418	81	128
10-18 (F)	9,833	94.8	535	5.2	10,368	79	132
10-21 (M)	7,905	94.3	480	5.7	8,385	64	131
10-22 (T)	10,698	88.9	1,360	11.1	12,058	91	132
10-23 (W)	10,673	93.4	750	6.6	11,423	83	137
10-24 (Th)	8,848	88.6	1,135	11.4	9,983	82	121
10-25 (F)	8,535	96.8	285	3.2	8,820	80	110
TOTAL	76,993		5,885		82,878	644	
TYP. DAY	9,624	92.9	735	7.1	10,359	80	129

TABLE II-4 PRODUCTION OF DISPOSABLE WASTES BY BUILDINGS

Building		Avg. Lbs.
No.	Function	Collected Daily
1	Unit I - Acute	5,510
2	Unit II - OB/Gyn.	1,570
3	Outpatients	930
4	Ped./CD	640
5	Psychiatric	570
6	Interns	400
7	Nurses	150
9	Pharmacy	80
10	Gen'l. Lab	60
16	Laundry	220
-	Misc.	170
	TOTAL	10,300

Shortly after this eight-day period of observations, the incinerator was closed down and a new system was improvised by General Services to haul all wastes to the landfill with the addition of one compactor truck. To complete the quantity survey, including all wastes now handled by both trucks, it was necessary to ride both vehicles and obtain weight records at the landfill. Observers on the trucks after obtaining tare weights, recorded refuse weights for a period of four days and the truck operators continued to provide scale records for an additional four day period. Table II-5 illustrates the truck weight records for this additional period of time, including the combined quantities of wastes which were formerly incinerated with those previously collected and hauled to the landfill. Total daily activity during this eight day period indicated 4.4 trips averaging 4,600 pounds (2.3 tons) or 20,550 pounds (10.25 tons) of disposable solid waste material were hauled daily to the private landfill. General observations of the truck activity prior to the incinerator shut down

TABLE II-5 LOAD RECORD 8-DAY PERIOD

Date	Truck No. 3368 Tare Wt. 18,660 Lbs. Gross Wt.	Truck No. 3368 Net Wt.	Truck No. 3369 Tare Wt. 18,560 Lbs. Gross Wt.	Truck No. 3369 Net Wt.	Total Daily Refuse Hauled
12-3 (Tues.)	21,220	2,560	24,630	6,070	
	---	---	24,500	5,940	14,570
12-4 (Wed.)	20,830	2,170	24,740	6,180	
	25,000	6,340	20,800	2,240	
	24,560	5,900	---	---	
	23,600	4,940	---	---	27,770
12-5 (Thurs.)	24,120	5,460	21,320	2,760	
	24,100	5,440	22,412	3,762	
	24,760	6,100	---	---	23,522
12-6 (Fri.)	24,870	6,210	21,530	2,970	9,180
12-7 (Sat.)	24,550	5,890	21,580	3,020	
	24,631	5,971	22,630	4,070	
	24,515	5,855	---	---	24,806
12-8 (Sun.)	24,605	5,945	21,453	2,893	
	24,320	5,660	22,300	3,740	18,238
12-9 (Mon.)	24,610	5,950	20,650	2,090	
	23,730	5,070	19,915	1,355	
	24,750	6,090	---	---	20,555
12-10 (Tues.)	24,300	5,640	21,430	2,870	
	24,820	6,160	23,410	4,850	
	24,863	6,203	---	---	25,723
No. of Trips:					
Avg./Day		2.5		1.9	4.4
Total Waste					
Avg. Day (Lbs.)		13,700		6,850	20,550
Avg. Load (Lbs.)		5,500		3,700	4,600

indicated it was making about three to four trips a day hauling estimated average loads of about one and a half tons or about 9,000 to 12,000 pounds daily. Final observations of the combined activity of both trucks reasonably confirmed these quantity estimates.

Following the above observations on the principal disposable wastes, there remained only two basic types of wastes with unknown quantities. These materials were food preparation wastes deposited directly in kitchen grinders and pathological wastes for disposal by incineration.

Hospital personnel in Dietary and Pathology assisted in determination of quantities of these materials in order to minimize disruption in these very active departments. The Chief Dietitian selected a day with menu requirements of foods with high volume of preparation wastes, which are the principal materials handled by the grinder installations. Personnel in the various preparation areas segregated this material and weighed the accumulated wastes prior to charging the grinders. Results of this activity presented a combined daily total of all food preparation wastes of 2,600 pounds. At the time of this survey, about 10,000 meals per day were prepared or it can be related that up to 0.26 pounds of waste per meal may be expected.

Surgery, autopsy and the laboratories generate the major quantities of segregated pathologic wastes. Technicians in these services over a three day period estimated volumes of wastes accumulated each day for disposal by the pathologic incinerator at approximately 187 gallons. Using a density factor of 5.2 lbs./gal. based on an allowed 70% moisture factor for this type of material, it is indicated that a total production of about 1000 lbs./day may be expected from these combined sources. Distribution of this material generated by the major producers for disposal by incineration is as follows:

Unit I	- Basement - Lab Services	30 gallons per day
	2nd Floor - Autopsy and Lab Areas	80 gallons per day
	2nd Floor - Laboratories	45 gallons per day
	16th Floor - Pathology Lab	30 gallons per day
Unit II	- 4th Floor - Surgical-Delivery	2 gallons per day

The prevailing handling practice at the time of observations involved storage of materials in closed containers with plastic liners, with delivery once daily via cart and/or elevator to the Can Room in Unit I for intermediate storage prior to disposal. Interviews with various personnel involved in handling and dispatch of these materials indicated differences of opinion as to routing and storage procedures.

Quantities and Types of Reusable Waste Materials:

To complete the quantity survey, data on reusable supplies and equipment classified as solid waste material in this study had to be developed. The principal identifiable materials in quantity in this classification are soiled linens, patient care and food service items.

Laundry records were found to be quite comprehensive, and daily weight records of soiled linen processed were readily available. Utilizing the most current month's records that were typical (October, 1968), an average calendar day production of some 45,500 pounds was calculated opposed to an average of 56,500 pounds processed daily. Table II-6 itemizes daily activity by shifts for the total number of days worked in the month of October.

Reusable food service items collected from the wards was calculated on the basis of number of patient meals served daily. Some variations occur with type of food service for various meals; however, an average of 1 1/2 lbs./patient meal was estimated. Based on 6,000 patient meals served per day, a daily quantity of some 9,000 pounds may be expected for return from the wards in food carts to the kitchen for reprocessing.

Patient care items presented greater difficulty in identifying a consistent handling system and basis for estimating quantities. In the case of patient care utensils, in most buildings cleaning or sterilizing facilities are available on each ward or within the building, and these materials are seldom seen in the inter-building system. The major reusable supplies circulated within the inter-building are reusable bottles from Pharmacy. These are generally transferred exclusively in racks or cartons by the Pharmacy tram train on the

TABLE II-6 SOILED LINEN PROCESSING - OCTOBER 1968

Date	Processing by Shifts (Lbs./Day)		
	1st Shift	2nd Shift	Total
1	21,970	19,085	41,055
2	29,970	24,890	54,860
3	29,135	30,545	59,680
4	29,530	29,307	58,837
5	19,845	---	19,845
7	29,760	26,290	56,050
8	28,813	28,500	57,313
9	27,640	29,880	57,520
10	22,885	30,340	53,225
11	27,865	30,370	58,235
14	26,500	29,690	56,190
15	30,290	31,250	61,540
16	28,360	30,525	58,885
17	31,410	30,930	62,340
18	32,525	30,905	63,430
19	18,675	---	18,675
21	31,730	30,885	62,615
22	27,700	33,845	61,545
23	30,775	32,950	63,725
24	32,220	31,890	64,110
25	28,995	29,215	58,210
28	31,980	31,930	63,910
29	31,085	31,350	62,435
30	33,295	32,293	65,588
31	33,925	32,790	66,715
TOTAL	716,878	689,655	1,406,533
	Average Lbs. Per Working Day		56,500
	Average Lbs. Per Calendar Day		45,500

return of carts to this department and then reprocessed in the bottle washing section. Observations during the entire period at this plant indicate that total patient care items expected to be handled daily in the inter-building system will be represented in trace amounts only.

Summary of Total Waste Production:

In summary, Table II-7 presents the types and quantities of wastes that may be expected to be generated daily at the Medical Center under its present level of service, and relates these quantities to the number of bed patients, number of employees and combined plant population, as well as total floor area of this building complex. The closing chapter of this volume will summarize our findings on all hospitals under study and attempt to establish patterns in the relationship of population or plant size to total waste production.

Equipment and Building Areas Used in System Operation:

For later economic analysis of the solid waste system, identification of all elements which contribute to its function is necessary. Included in these elements are building areas and equipment used exclusively in waste handling, storage, processing and disposal, and equipment shared with other services.

Excluding the numerous trash and soiled linen chute rooms considered as cost elements of the in-building system, building areas used in the inter-building waste system are limited to (1) the abandoned incinerator presently used as a central storage and loading area for disposable wastes, (2) the covered storage area for soiled linen, and (3) the two rooms housing pathologic incinerators. Collectively, the replacement costs of present covered storage area requirements for disposable wastes and soiled linens (about 2,000 square feet) should not exceed a nominal $20,000.00 investment. The pathologic incinerator rooms (about 250 square feet of building area) based on a nominal $25.00 per square foot building cost allowance would represent an investment of about $6,000.00. The balance of areas in the inter-building system used for storage and processing as well as transfer routes are of mixed use and cannot be directly

TABLE II-7 SUMMARY OF DAILY WASTE PRODUCTION

Type of Waste	Avg. Wt. Lbs./Day	% of Total	*Daily Production Factors Lbs./Bed Patient	Lbs./Capita
Sharps, Needles, Etc.	75	.1	TR	TR
Path. & Surgical	1,000	1.3	.5	TR
Soiled Linen	45,500	58.6	22.8	2.2
Rubbish	16,200	20.9	8.1	.8
Reusable Patient Items	TR	TR	TR	TR
Non-Combustibles	1,500	1.8	.7	TR
Garbage (Non-Grindable)	1,800	2.3	.9	.1
Food Service Items	9,000	11.6	4.5	.4
Ash & Residue	TR	TR	TR	TR
Animal Carcasses	25	TR	TR	TR
Food Waste (Grindable)	2,600	3.4	1.3	.1
TOTAL WASTES	77,700	100.0	38.8	3.7
Total Disposable	23,200	29.9	11.6	1.1
Total Reusable	54,500	70.1	27.2	2.6

*Based Avg. Census of 2,000 Bed Patients Daily and Gross Population of 21,000

Note - Total Production Related to Gross Bldg. Area of 3,000,000 SF:
Disposables @ 7.5 Lbs./MSF, Reusables @ 18.1 Lbs./MSF
or Total of 25.6 Lbs./MSF Daily.

allocated to the waste system.

The principal equipment acquired for exclusive use in the inter-building waste system includes the pathologic incinerators, all soiled linen carts, trash carts and portable bins. The equivalent of two tram train power units are also used in transporting reusable and disposable waste materials. The balance of carts used for transport of clean supplies and return of reusables or disposable materials should be allocated to the movement of clean supplies and not to the waste system.

Equipment utilized in the off-site system is limited to the 13 cubic yard compactor truck providing the building to building collection service and the new 33 cubic yard compactor truck which handles the majority of materials formerly incinerated.

A summary of these elements in the inter-building and off-site systems is presented in Table II-8, which shows the inventory and cost allowance of each item. This estimate based on approximate replacement costs indicates a capital investment of about $68,250.00 required to duplicate building areas and equipment used in the inter-building system, and $52,000.00 for equipment used in the off-site system.

TABLE II-8 COSTS OF BUILDING AND EQUIPMENT IN INTER-BUILDING AND OFF-SITE SYSTEM

			Est. Value
Inter-Building System:			
Building Areas (Incinerator rooms & covered storage areas)			$ 26,000
Equipment:			
2 - Tram Train Tractors	@ $3000 =	$ 6,000	
10 - Flatbed Trash Carts	@ 200 =	2,000	
35 - Portable Trash Bins	@ 350 =	12,250	
30 - Soiled Linen Carts	@ 200 =	6,000	
8 - Tank Carts	@ 750 =	6,000	
2 - Patho. Incinerators	@ 5000 =	10,000	
ESTIMATED EQUIPMENT COST			42,250
Off-Site System:			
1 - 13 CY Compactor Truck		15,000	
1 - 33 CY Compactor Truck		37,000	
ESTIMATED EQUIPMENT COST			52,000*
EST. REPLACEMENT COST OF BUILDINGS AND EQUIPMENT			120,250

Subcontract Services and Disposal Fees:

A disposal fee for those materials hauled to the private landfill has been established at $4.00 per ton, plus $1.00 per load for special handling of hospital wastes. In practice, loads are not generally weighed and charges are made on a truck load basis. However, based on the daily production of about 10 tons and using the above rates, charges should be in the range of $45 to $50 per day for off-site disposal, dependent on the number of loads required. With the larger compactor truck recently added to the system, the minimum rate will probably be achieved.

One contract not specifically related to the economic analysis of the inter-building and off-site system has been issued to a private contractor for collection, transportation and disposal of radioactive waste material in accordance with State and Federal regulations. This contract provides for removal of special 55 gallon containers at a cost of $27.55 per container. Current experience indicates about eight drums per year are handled.

Personnel Requirements:

From field records of the entire period of observations, it is estimated that average daily activity of the inter-building and off-site systems involves an equivalent of about sixteen men. About one third of this manpower is represented by truck and tram operators, with the remainder consisting of laundry workers, institutional laborers, custodians, etc. performing loading, unloading or other handlings of the various types of waste materials. Further detail on the labor force, including cost data, is shown later in this chapter.

OBSERVATIONS OF THE IN-BUILDING SYSTEM

Continuing observations at the Medical Center were carried out to determine the detailed functions of the in-building operation (Unit and Inter-Unit Systems). Cursory inspection of the major buildings in the plant was accomplished with the assistance of area supervisors of Housekeeping and Custodial Services. The purpose of this inspection was primarily to compare methods and practices employed in the various departments and buildings and to select "typical" wards and stations for in-depth observations.

General:

These cursory inspections revealed or confirmed the complexity and confusion that usually exists within the waste handling operations of hospitals. These complexities are "built-in" through the multitude of different materials and supplies that are distributed and used throughout the hospital daily. Emphasis is placed on the importance of distribution of new materials with little direction given in handling the residual waste materials.

Detailed studies by staff members of the University of Minnesota[1] have been made previously in the field of hospital wastes, cataloging and itemizing typical components of mixed refuse to be found in various hospitals. These materials can be broadly categorized into (1) wood and paper products, (2) cloth or fiber, (3) plastics and rubber, (4) plants and miscellaneous foods, (5) miscellaneous non-combustibles, (6) medications, and (7) reusables.

In addition to these categories of wastes that are generated throughout the hospital, additional concentrations of wastes requiring special handling are occasionally passed into the general waste system, bypassing intended channels. Similarly, in many cases, mixed refuse of the above material categories, dependent on point of generation, such as isolation wards, etc., are also intended for special handling but are inadvertently channeled into the general waste system. Confusion in proper handling methods may be introduced by high turnover of personnel, difficulty in identifying the material after it passes through the first hands, language difficulty, morale, and improper equipment.

(1) Bacterial Contamination From Hospital Solid Waste, R. G. Bond and G. S. Michaelsen, Research Grant EF-00007-04 National Institute of Health, 1964.

First observations confirmed the general kinds and intermix of materials prevailing in the system. Rather than devote extensive field time to cataloging the components of the mixed waste materials, observations were directed to the mechanics of handling, handling techniques associated with all types of wastes, equipment used, and time devoted by personnel classifications in various aspects of waste handling in an effort to establish operating standards, efficiencies, and a basis of determining costs of the present waste system operation.

Initial inspections were confined to the Acute Unit (Building 1), O.B./Gyn. (Building 2), Outpatients (Building 3), Communicable Disease (Building 4), Psychiatric (Building 5), and various laboratories and kitchen areas. Observations, together with interviews with custodial personnel and supervisors, as well as floor nurses and nurses' supervisors, assisted in providing a basis of labor estimates.

Handling of Disposable Waste Materials:

It was generally observed, as may be expected, that disposable wastes are created and/or handled by all personnel, patients and visitors in a continuing daily flow. However, upon deposit in the initial container, handling of disposable wastes immediately becomes limited to the Housekeeping and Custodial staff.

Wastebaskets in patients' rooms and other initial containers are usually wiped out with disinfectants and lined with plastic bags after use. Floor workers, along with general cleaning duties, empty these containers by removing the filled plastic bags and placing them into a plastic lined cloth bag suspended on the custodial cart. When the plastic liner is filled, a custodian wheels the cart to the nearest trash chute, ties the bag closed, and deposits it in the chute.

Though a relatively simple system, breakdowns occur due to innumerable reasons, including shortages of plastic bags, monotony of the routine, etc. Plastic liners are on occasion omitted from containers or from the cloth bag on the custodial cart. Occasionally, the plastic liners of the cloth bag are filled to excess and cannot be tied or are too large to enter the chute door. These circumstances then create additional time, effort and risk in handling. Typical alternative handling methods may include (1) dumping of loose material in chutes, (2) hand carried or stretcher borne bags of trash transported by elevator to the intermediate storage rooms, (3) improper storage on the floor, and (4) rebagging of materials for deposit in chutes, all of which give greater exposure of the environment to the material and increase handling costs.

Miscellaneous segregated waste materials on each floor, including non-combustible items, syringes and needles, and double-bagged medical wastes, as well as surgical and pathological wastes from limited locations, are collected separately in cans, which are manually transported by custodial personnel via elevator or stairs to service level intermediate storage locations for later retransfer to selected disposal stations.

Handling of Reusable Waste Materials:

Custodial personnel are not as greatly involved in the initial handling of reusable waste materials. The nursing staff and nurses aides (attendants) are the primary handlers of this material prior to use and after its conversion from clean to dirty classification. They remove soiled linen, bag (cloth) or bundle the material and hand carry it to the nearest chute for deposit in same. Highly contaminated linens from certain areas may be double-bagged or plastic-bagged prior to deposit within the chute system. Similarly, they also collect used food service items from patient rooms after meals, bag disposable food wastes, and assemble all implements on food carts to await pickup by custodial personnel. These carts are then escorted via elevator transport, and grouped at intermediate collection points at service level to await the inter-building transfer to the main kitchen. Patient care items are also collected by nurses or attendants and hand carried to on-floor cleaning and/or sterilizing facilities for reprocessing. Reusable bottles, largely from the pharmacy department, are collected as required, placed in racks or cartons and stored in utility rooms or corridors until picked up by pharmacy personnel for return via elevator and tram train for reprocessing.

Personnel Requirements:

Minor variations occur in the on-floor unit system of handling solid wastes. However, the previously described methods prevail in the major waste-producing areas. To relate personnel requirements to this operation, various departments and typical wards were observed. Four wards were selected for detailed observations of personnel involved in the daily routines of housekeeping functions. Observations of shift routines at each of these wards were made over a period of four days, recording time devoted to handling of the principal solid waste material, including sharps, soiled linen, patient care and food service items, rubbish and non-combustibles.

The observed time devoted to waste handling as recorded was consistently less than estimated by the various supervisory personnel in each classification. It also appeared more reasonable as a basis for this estimate and determination of unit factors that could be used in projecting total estimated manpower requirements. Similar observations were made in other areas of the in-building system and composite time factors of all personnel involved in waste handling were developed. These factors were related to the major types of wastes and were resolved to minutes per day per bed patient in handling each material. Projections of total manhour and equivalent manday requirements for the in-building system, shown in Table II-9, indicate an equivalent of 180 mandays are required daily in these waste handling activities. Table II-9 also relates this labor force to personnel classifications and shows the composite time factor (minutes/bed) utilized in these projections.

As noted earlier in this report, estimated labor is specifically limited to (1) the handling of disposable waste materials from the point of initial deposit through the point of disposal and (2) the handling of reusable materials after use up to the point of storage or accumulation preceding reprocessing. Estimated labor as shown does not include general cleaning duties of custodians or handling of clean supplies that may later be converted to wastes.

TABLE II-9 DAILY REQUIREMENTS FOR IN-BUILDING WASTE HANDLING

Type of Waste	Manhours by Personnel Classifications						Equiv. Man Days	Min. Per Bed
	Nurses	Aides	Cust.	Lndry. Wrkr.	(1) Other	Total		
Sharps	--	--	92	--	--	92	11	2.8
Soiled Linen	94	94	67	34	--	289	36	8.7
Reusable Patient Items	16	66	--	--	--	82	10	2.5
Food Service Items	142	142	--	--	7	291	36	8.7
Rubbish	--	--	559	--	--	559	70	16.7
Non-Comb.	--	--	95	--	--	95	12	2.9
Other (2)	--	--	--	--	44	44	5	1.3
TOTAL	252	302	813	34	51	1452	180	43.6
Equivalent Man Days	31	37	102	4	6	--	180	--

(1) Lab. Tech., Food Service Worker, Elev. Operator, Institutional Laborer

(2) Pathological, Garbage (Non-Grindable), Radiological

Table II-10 was prepared to illustrate the manpower load requirements on major personnel classifications involved in the in-building solid waste system. It shows average daily personnel available (7 day basis) and the number and percent required for handling of solid wastes. Further detail on personnel requirements, including cost estimates, in handling of solid wastes within the various components of the system will be presented at the close of this chapter.

TABLE II-10 LABOR REQUIREMENTS OF IN-BUILDING WASTE SYSTEM

Personnel Classifications	Man Day Distribution		
	(1) Total Available	Required for Waste Handling	
		Man Days	% of Tot.
Nurses	1,047	31	2.9%
Nurses Aides	2,272	37	1.6%
Custodians	327	102	31.2%

(1) 7-Day Basis (5/7 of Ordinance Positions)

Equipment and Building Area Requirements:

Principal building areas and equipment utilized in the in-building waste system are limited to the soiled linen and trash rooms, shaftways housing chutes and the fixed equipment (chutes and access doors). Collectively, the 18 pairs of soiled linen and trash rooms, together with shaftways, chutes and hardware, represent an investment estimated at about $345,000 in building and equipment exclusively used by the in-building solid waste system. Table II-11 shows the breakdown of these costs based on nominal allowances of $25.00 per square foot for building area and $3.00 per cubic foot for shaftways.

TABLE II-11 BUILDING AREAS AND EQUIPMENT OF THE IN-BUILDING SYSTEM

Building Areas and Volumes:		Est. Value
1 Can Storage Room	500 SF @ $25/SF	$ 12,500
18 Trash Rooms @ Avg. 155 SF Area = 2800 SF @ $25/SF		70,000
18 Soiled Linen Rooms @ Avg. 275 SF Area = 5000 SF @ $25/SF		125,000
3620 LF Chute-Shafts @ 6 CF/LF = 21,720 CF @ $3/CF		65,160
	Total Building Value Allowance	$272,660
Fixed Equipment:		
3620 LF Trash and Linen Chutes @ $20/LF Installed		$ 72,400
TOTAL BLDG. & FIXED EQUIPMENT		$345,060

ESTIMATED OPERATING COST OF THE TOTAL SYSTEM

Building, equipment and labor involved in the system operation have been explored in detail in the preceding sections of this chapter. An investment of some $370,000 has been calculated for those portions of the physical plant and fixed equipment that are exclusively used in solid waste handling functions. Projecting the estimated value of buildings and fixed equipment on a thirty-five year basis with a nominal interest rate of 5% (average annual amortization rate at 6.107%) results in an average expense of about $23,000 per year, or $63.00 per calendar day. A reasonable budget allowance for maintenance and repairs of these types of facilities should be equal to about 2% of building costs, or some $7,400 a year, or $20 per day.

Operating costs for vehicular equipment will include such items as maintenance and repairs, tires, fuel, service, licenses, etc. For the most part, though all power vehicles are operated on relatively low mileage basis, most of the equipment is operated at least at idling speed during active work shifts. Therefore, an average of 8 hours per day on a 7 day week basis or about 3,000 operating hours per year has been allowed in the following calculations of total annual and average daily equipment costs. Table II-12 summarizes the equipment referred to earlier in this report, together with capital and operating expenses they represent.

TABLE II-12 ESTIMATED ANNUAL EQUIPMENT OPERATING COST

Equipment Item	Cost Allowance	Oper. & Maint. Cost	Annual Oper. & Maint. Cost	Annual Depre-ciation	Total Annual Cost
1-33 CY Comp. Truck	$37,000	$3.50/Hr.	$ 10,500	$ 3,700	$14,200
1-13 CY Comp. Truck	15,000	2.50/Hr.	7,500	1,500	9,000
TOTAL OFF-SITE EQUIPMENT			$ 18,000	$ 5,200	$23,200
2-Tram Train Tractors	$ 3,000	$1.25/Hr.	$ 7,500	$ 600	$ 8,100
10-Flatbed Trash Carts	200	10% of Val.	200	200	400
35-Portable Trash Bins	350	10% of Val.	1,225	1,225	2,450
30-Flatbed Linen Carts	200	10% of Val.	600	600	1,200
8-Tank Carts	750	10% of Val.	600	600	1,200
2-Pathol. Incin.	5,000	--	1,000	1,000	2,000
TOTAL INTER-BUILDING EQUIPMENT			$ 11,125	$ 4,225	$15,350
TOTAL EQUIPMENT			$ 29,125	$ 9,425	$38,550

In addition to the foregoing costs, labor for the total system, including payroll taxes and insurance and social benefits, has been calculated at about $2,275,000 annually or $6,232 per calendar day. Table II-13 relates types of employees involved in waste handling and the distribution of estimated labor costs to the various types of wastes (reusables and disposables) and components of the total waste system.

TABLE II-13

ESTIMATED **DAILY** LABOR COSTS OF HOSPITAL SOLID WASTE SYSTEMS

LAC-USC MEDICAL CENTER

Types of Waste	Unit System: Type Employee	Pay Rate	Hr./Day	Emp. Total	Unit System Total	Inter-Unit System: Type Employee	Pay Rate	Hr./Day	Emp. Total	Unit System Total	Inter-Building System: Type Employee	Pay Rate	Hr./Day	Emp. Total	Unit System Total	Off-Site System: Type Employee	Pay Rate	Hr./Day	Emp. Total	Unit System Total	TOTAL
Sharps, Needles, Etc.	Custodian	$3.71	17.0	$ 63.07	$ 63.07	Custodian	$3.71	75.0	$278.25	$278.25	Tram Dr.	$4.03	0.5	$ 2.02	$ 6.05	Inst. Lab.	$4.03	2.1	$ 8.46	$ 11.78	$ 359.15
											Inst. Lab.	4.03	1.0	4.03		Truck Dr.	4.74	0.7	3.32		
Pathological and Surgical	Lab.Tech.	4.12	1.0	4.12	5.98	Custodian	3.71	0.5	1.86	1.86	Inst. Lab.	4.03	2.0	8.06	8.06						15.90
	Custodian	3.71	0.5	1.86																	
Soiled Linen	Nurse	5.72	94.0	537.68	1100.21	Laund.Wk	3.25	34.0	110.50	110.50	Tram Dr.	4.03	6.5	26.20	44.73						1255.44
	Attendant	3.34	94.0	313.96							Laund.Wk	3.25	5.7	18.53							
	Custodian	3.71	67.0	248.57																	
Rubbish	Custodian	3.71	535.0	1984.85	1984.85	Inst. Lab.	4.03	24.0	96.72	96.72	Tram Dr.	4.03	5.1	20.55	20.55	Inst. Lab.	4.03	18.9	76.17	132.58	2234.70
																Truck Dr.	4.74	11.9	56.41		
Reusable Patient Items	Nurse	5.72	15.0	91.52	311.96																311.96
	Attendant	3.34	66.0	220.44																	
Non-Combustible	Custodian	3.71	20.0	74.20	74.20	Custodian	3.71	75.0	278.25	278.25	Tram Dr.	4.03	0.5	2.02	6.05	Truck Dr.	4.74	0.6	2.84	2.84	361.34
											Inst. Lab.	4.03	1.0	4.03							
Garbage (Non-Grindable)	Fd. Srv.Wk	3.42	6.0	20.52	20.52	Fd.Srv.Wk	3.42	4.5	15.39	20.96	Tram Dr.	4.03	4.5	18.14	18.14	Inst. Lab.	4.03	17.8	71.73	122.45	182.07
						Elev. Op.	3.71	1.5	5.57							Truck Dr.	4.74	10.7	50.72		
Food Service Items	Nurse	5.72	142.0	812.24	1286.52	Elev. Op.	3.71	7.25	26.90	26.90	Tram Dr.	4.03	3.5	14.11	89.78						1403.20
	Attendant	3.34	142.0	474.28							Fd.Srv.Wk	3.42	18.0	61.56							
											Inst. Lab.	4.03	3.5	14.11							
Radiological	Lab. Tech	4.12	0.5	2.06	2.80	Elev. Op.	3.71	0.3	1.11	2.22	Custodian	3.71	1.0	3.71	3.71						8.73
	Custodian	3.71	0.2	0.74		Custodian	3.71	0.3	1.11												
Ash & Residue	Inst. Lab.	4.03	0.1	0.40	0.40	Inst. Lab.	4.03	0.1	0.40	0.40	Tram Dr.	4.03	0.1	0.40	0.40	Inst. Lab.	4.03	0.2	0.81	1.28	2.48
																Truck Dr.	4.74	0.1	0.47		
Animal Carcasses	Lab.Tech.	4.12	0.75	3.09	3.09						Lab.Tech.	4.12	0.5	2.06	2.06						5.15
Food Waste (Grindable)	Fd.Srv.Wk	3.42	27.0	92.34	92.34																92.34
					$4945.94					$816.06					$199.53					$270.93	$6232.46

Certain other operating costs lie in the area of the miscellaneous expendable supplies, such as replaceable containers and disposable bags, etc. used throughout the plant. A nominal allowance of $100.00 per day has been established for this factor based on quantities of refuse produced and estimated numbers of containers. A summary of the estimated annual and daily expenses of the system based on the foregoing data is shown in Table II-14, which also relates these costs to the various components of the waste system.

TABLE II-14 DISTRIBUTION OF ESTIMATED ANNUAL COSTS TO WASTE SYSTEM COMPONENTS

Cost Elements	System Components - Estimated Annual Cost of Operation						
	Unit	Inter-Unit	Inter-Building	Off-Site	Total		Avg. Cost Per Day
					Cost	%	
Bldg. & Fixed Equip.	$ -0-	$ 21,500	$ 1,500	$ -0-	$ 23,000	1.0	$ 63
Maint. & Repairs	-0-	6,880	520	-0-	7,400	0.3	$ 20
Vehicular Equip. Carts	-0-	-0-	4,225	5,200	9,425	0.4	$ 26
Oper. & Maint.	-0-	-0-	11,125	18,000	29,125	1.2	$ 80
Disposal Fees	-0-	-0-	-0-	16,400	16,400	0.7	$ 45
Misc. Expend. Supplies	12,250	12,250	12,000	-0-	36,500	1.5	$ 100
SUB-TOTAL	$ 12,250	$ 40,630	$ 29,370	$ 39,600	$ 121,850	5.1	$ 334
Labor (Taxes, Ins., Benefits)	1,805,000	298,000	73,000	99,000	$2,275,000	94.9	$6,232
TOTAL	$1,817,250	$338,630	$102,370	$138,600	$2,396,850	--	--
Avg. Cost Per Day	$ 4,980	$ 926	$ 280	$ 380	$ --	--	$6,566
% of Total	75.8%	14.1%	4.3%	5.8%	--	100.0%	--

Collectively all costs of equipment, buildings, etc., exclusive of labor, are slightly more than 5% of the total annual costs of the waste system. It is of interest to note that total annual costs of the waste system are equivalent to 2.6% of the total annual operating budget of the Medical Center, which in 1969 was $79,826,000.

Table II-15 provides a comparison of the respective costs of handling disposable and reusable wastes, excluding only the costs of reprocessing the reusable materials.

TABLE II-15 COST COMPARISON OF DISPOSABLE AND REUSABLE WASTES

Type of Waste	Avg. Wt. Lbs./Day	Daily Costs of Handling & Disposal					
		Labor	Bldg. & Equip.	*Other	Total	Avg. Cost	
						Per Ton	Per Bed
Disposables:							
Rubbish	16,200	$2,235	$104	$ 85	$2,424	$300	$1.22
Other	7,000	1,027	40	60	1,127	322	.56
Total	23,200	$3,262	$144	$145	$3,551	$305	$1.78
Reusables:							
Soiled Linen	45,500	$1,255	$ 45	--	$1,300	$ 57	$0.65
Food Service Items	9,000	1,403	--	--	1,403	312	.70
Other	TR	312	--	--	312	--	.15
Total	54,500	$2,970	$ 45	--	$3,015	$110	$1.50
Total All Materials	77,700	$6,232	$189	$145	$6,566	$170	$3.28

*Miscellaneous expendable supplies and dumping fees

The cost estimates as presented herein are based upon observations and judgments, generally without benefit of record data or statistics. Costs of building areas and equipment as well as hourly rates of labor are based on nominal average unit cost allowances. Waste quantities and manhour estimates, of course, are based on actual observations. Certain extrapolations have been made which by analysis of time (minutes per bed) and costs per bed appear to be reasonable.

The final chapter of this volume will provide cost comparison of solid waste systems in all hospitals under study and the cost "yardstick" to assist in the evaluation of systems.

Alternative methods of waste handling and disposal to be explored in Volume IV of this study will also provide cost comparisons of considered alternatives for the Medical Center system.

OBSERVATIONS ON AEROSOL CONTAMINATION

Previous research through air and surface sampling has been performed in various hospitals in the country, relating the effects of waste handling activities on the environment and the resulting contamination which may likely occur. Specific investigations by Bond and Michaelsen (Bacterial Contamination from Hospital Solid Wastes - 1964) had given insight into expected effects of waste handling practices on airborne microflora. They had indicated, for instance, that soiled laundry handling was by far the most significant influence on increased airborne bacteria. They also indicated general levels of airborne bacteria associated with various hospital areas and had suggested that such factors as activity levels and ventilation patterns could greatly affect sampling results.

As part of the waste handling evaluation at the Medical Center, it was decided to obtain a limited quantity of data concerning microbiological aerosolization by actually monitoring procedures in several locations specifically selected for their proximity to waste handling activities. The main objective was to demonstrate similar effects to those previously reported, actually occurring in the hospital being studied and to emphasize the potential hazards that exist in these less obvious sources of contamination. Local field experimentation was conducted at the Medical Center in March, 1969. This program was limited to air sampling for quantitative estimates of airborne bacteria at selected locations in the plant. Field testing and lab analysis were performed by personnel of the Los Angeles County Health Department in collaboration with special consultants from the Division of Environmental Health and Safety, School of Public Health, University of Minnesota.

Equipment and Procedures Used:

The air samplers chosen for the study were Elliot Slit Samplers. These samplers were connected to vacuum pumps and equipped with gauges to regulate airflow to one cubic foot per minute. The samplers operate on the slit impaction principle. Air sampling plates are placed on a turntable adjusted to a distance of 2 mm between the bottom of the slit and the agar surface. Two samplers were employed. One was set for one revolution of the turntable in two minutes (two cubic feet) while the other made one revolution in six minutes (six cubic feet). Prepoured plates containing Trypticase Soy Agar were obtained for the program. Plates were incubated at 37° C for 20-24 hours after sampling, then counted. When plates were too heavily contaminated for accurate counting, results were recorded as TNTC and arbitrarily assigned a value of 200 col/cu ft.

Observations at Selected Sampling Stations:

The areas selected for sampling included the following:

1. Trash chute rooms and the adjacent corridor in the service level of the Acute Unit (Bldg. No. 1) at the Medical Center.

2. Laundry chute rooms and adjacent corridor areas at the same level.

3. The soiled linen sorting area at the laundry.

4. One soiled utility room on an upper story nursing station.

Each of the selected areas was sampled on several occasions. On those days when the chute rooms and adjacent corridors were being sampled, one sampler was set up in the room while the other was located in the corridor near the door, which was kept closed except when entry was necessary. A sample was run on each machine approximately every 15 minutes, starting between 6:30 and 7:30 a.m. and continuing for some 6 to 8 hours. A detailed record of activity associated with each sample was kept. Additional samples were sometimes run directly associated with a specific waste handling activity, such as loading of trash or laundry into carts. Figure II-6 shows the typical arrangement of air sampling equipment during sampling procedures.

Figure II-6 Air Sampling Procedures in Soiled Linen Room

In the soiled linen sorting area, one machine was set up near the start of the belt operation and the other near the end. Again sequential samples were taken every 15 minutes or so for 4 or 5 hours. On the nursing station the two machines were located on opposite sides of the soiled utility room.

Results of the Sampling Program:

The overall results of the air sampling program are summarized in Table II-16.

TABLE II-16 SUMMARY OF AIR SAMPLING DATA

Station	# Observations	Mean col/ cu. ft.	# of TNTC Plates
Trash Chute Room - Inside	99	14.1	2
Outside	96	8.8	0
Laundry Chute Room - Inside	58	38.3	2
- Outside	57	31.4	5
Soiled Linen Sorting Area	54	71.0	7
Station Utility Room	55	5.0	0

It is obvious that the laundry handling operation does generate considerably greater aerosols than does the trash handling. This is consistent with the conclusions of Bond and Michaelsen. Also of considerable interest is the finding that colony counts in the corridor adjacent to the soiled linen chute rooms were almost as high as in the storage room itself. Thus, it appears that the soiled linen handling operation as currently practiced might actually result in exposing the great number of persons utilizing the adjacent corridor to increased airborne contamination.

It is somewhat surprising that the corridor outside of the soiled linen chute rooms should be significantly more contaminated than the same corridor outside of trash chute rooms, as the trash and soiled linen storage rooms are often in close proximity to each other. One possible explanation might be that the pattern of air movement in the tunnel is from the trash rooms toward the soiled linen rooms.

In summary, the air sampling program has demonstrated, in agreement with previously published reports, that soiled linen handling is a significant source of airborne contaminants and that even when the activity is confined to a storage room with the door closed most of the time, the effect can be demonstrated in adjacent areas.

EVALUATION OF EXISTING SYSTEM OPERATION

The evaluation of the performance capabilities of the existing solid waste system at the Medical Center has been based upon observations of the plant, equipment and operating techniques employed in its operation. As an aid for evaluation of the system, a summary description of the total solid waste system, Table II-17, was prepared, showing typical daily production of the various types of wastes and the prevailing methods of performing the various function within each of the system components (Unit, Inter-Unit, Inter-Building and Off-Site System) for each type of waste.

As indicated in the Table, the task of the movement of waste materials at the Medical Center is largely manual in nature. Although equipment presently employed provides mechanical means of vertical and horizontal transportation over substantial distances for those wastes of the greatest quantities (soiled linen and rubbish, etc.), movement of each of these wastes generally involves a minimum of four different modes of transport, and four to five physical rehandlings or transfers of the loose or contained materials, between the points of initial deposit and their ultimate resting place. An extreme contrast to these methods may be observed in the direct closed system afforded food preparation wastes, which are generally limited to a single handling as they are deposited directly in the kitchen grinders soon after creation.

It is evident that evaluation of the existing systems for handling the various types of waste materials within the complex will, in the majority of cases, depend upon methods of preparation of waste materials and reflect the performance of labor handling this material, working generally without benefit of specialized equipment. Malfunctions of any of the limited equipment in the system will tend to handicap labor further in satisfactorily performing its functions and affect standards throughout the respective waste system.

TABLE II-17 DESCRIPTION OF HOSPITAL SOLID WASTE SYSTEMS LAC-USC MEDICAL CENTER

			Unit System			Inter-Unit System		Inter-Building System			Off-Site System	
Type of Waste	Av. Daily Weight	% of Total	Initial Deposit (Receiver)	Initial Transfer	Initial Storage, Processing, Disposal	Vertical Transfer	Intermediate Storage, Processing, Disposal	Internal Transfer	Central Storage	Central Processing or Disposal	External Transfer	Final Processing and/or Disposal
Sharps, Needles, Etc.	75	.1	Lined Open Container	Manual	Utility Room	Elevator	Can Room	Cart Train	Cart	Loading Dock	Hospital Packer Truck	Landfill
Pathological and Surgical	1,000	1.3	Lined Closed Container	Manual	Utility Room	Elevator	Can Room	Cart Train	Cart	Loading Dock	Hospital Packer Truck	Landfill
Soiled Linen	45,500	58.6	Cloth Bag	Manual	Corridor	Gravity Chute	Chute Room	Cart Train	Open Storage Area	Laundry	---	---
Rubbish	16,200	20.9	Lined Open Container	Hand Cart	Utility Room	Gravity Chute	Chute Room	Cart Train	Cart	Loading Dock	Hospital Packer Truck	Landfill
Reusable Patient Items	---	---	---	Manual	Utility Room Autoclave	---	---	---	---	---	---	---
Non-Combustible	1,500	1.8	Lined Open Container	Manual	Utility Room	Elevator	Can Room	Cart Train	Cart	Loading Dock	Hospital Packer Truck	Landfill
Garbage (Non-Grindable)	1,800	2.3	Special Cart	Special Cart	Corridor	Elevator	Corridor	Cart Train	Special Cart	Loading Dock	Hospital Packer Truck	Landfill
Food Service Items	9,000	11.6	Special Cart	Special Cart	Corridor	Elevator	Corridor	Cart Train	Corridor	Kitchen	---	---
Radiological	TR	TR	Special Container	Manual	Special Container	Elevator	---	Hand Cart	Roof Top	---	Private Contractor	Federal Landfill
Ash & Residue	TR	TR	Closed Container	Manual	---	Stairs	Can Room	Cart Train	Cart	Loading Dock	Hospital Packer Truck	Landfill
Animal Carcasses	25	TR	Closed Container	Manual	---	---	---	Cart	Refrigerator	---	City Truck	Rendering
Food Waste (Grindable)	2,600	3.4	Open Container	Manual	Grinder	Sewer	---	Sewer	---	---	Sewer	Sewer Treatment Plant

The Developed Rating:

In the development and application of evaluation methods adopted for this study, general guidelines were established for rating the various types of equipment and methods employed in each function of the system for handling the respective types of waste. Evaluation of the total system was based on observations over a period of some sixty days, during which various malfunctions in the system occurred. However, the evaluation was based on what appeared to be prevailing practices and conditions during this period. Table II-18 presents the composite deficiency rating as developed by the project staff, and follows the format established in the introductory section in Volume I. Proper interpretation of the rating of individual waste systems will indicate those areas of the system where remedial measures should be considered. It would appear that minimizing rehandling and exposure of all waste materials within the plant by means of a closed transport system, with no interruption between the initial points of dispatch and processing or disposal stations would provide the optimum in solid waste system.

Discussions on remedial measures to be considered as suggested by the deficiency rating of the individual waste systems at the Medical Center are presented in Volume IV.

TABLE II-18 NUMERICAL RATING OF HOSPITAL SOLID WASTE SYSTEMS LAC-USC MEDICAL CENTER

Type of Waste		Unit System								Inter-Unit System						Inter-Building System								Off-Site System							
		Initial Deposit (Receiver)		Initial Transfer		Initial Storage, Processing, Disposal		Def.	Max.	Vertical Transfer		Intermediate Storage, Processing, Disposal		Def.	Max.	Internal Transfer		Central Storage		Central Processing or Disposal		Def.	Max.	External Transfer		Final Processing and/or Disposal		Def.	Max.	Def.	Max.
		Def Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Value Total	Value Total	Def. Value	Max. Value	Def. Value	Max. Value	Value Total	Value Total	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Value Total	Value Total	Def. Value	Max. Value	Def. Value	Max. Value	Value Total	Value Total	Value Total	Value Total
Sharps, Needles, Etc.	Sanitation	30	40	38	50	15	20	83	110	40	50	15	20	55	70	40	50	5	10	20	20	65	80	10	20	80	80	90	100	293	360
	Safety	30	40	25	50	5	10	60	100	25	45	5	10	30	55	30	45	2	5	10	10	42	60	5	10	75	75	80	85	212	300
	Security	15	30	2	5	20	25	37	60	0	5	13	25	13	30	5	5	25	25	10	10	40	40	0	10	60	60	60	70	150	200
	Esthetics	5	5	2	5	2	5	9	15	2	5	2	5	4	10	2	5	5	5	5	5	12	15	3	5	20	20	23	25	48	65
Surgical, Patho-logical & Animals	Sanitation	10	20	15	35	25	35	50	90	15	20	35	35	50	55	5	10	10	10	40	40	55	60	20	20	75	75	95	95	250	300
	Safety	2	5	5	10	2	5	9	20	2	5	7	10	9	15	12	15	10	10	5	5	27	30	5	5	5	5	10	10	55	75
	Security	0	5	0	5	35	35	35	45	0	5	25	35	25	40	2	5	20	20	5	5	27	30	2	10	75	75	77	85	164	200
	Esthetics	5	10	2	5	11	15	18	30	2	5	11	15	13	20	2	5	15	15	10	10	27	30	5	5	15	15	20	20	78	100
Soiled Linen	Sanitation	30	40	35	50	22	30	87	120	40	80	40	50	80	130	25	30	30	30	20	40	75	100		10		40		50	242	400
	Safety	2	5	2	5	2	5	6	15	0	5	2	5	2	10	5	10	5	5	7	15	17	30		5		15		20	25	75
	Security	2	5	2	5	5	5	9	15	0	5	5	15	5	20	7	15	20	20	2	5	29	40		15		5		20	43	95
	Esthetics	15	20	10	15	7	10	32	45	5	10	10	10	15	20	5	5	5	5	2	5	12	15		5		15		20	59	100
Rubbish	Sanitation	2	5	5	10	5	10	12	25	10	20	10	15	20	35	5	10	5	10	15	15	25	35	5	10	40	55	45	65	102	160
	Safety	7	15	10	20	13	25	30	60	0	20	25	45	25	65	7	15	13	25	25	25	45	65	0	10	20	25	20	35	120	225
	Security	2	5	2	5	15	20	19	30	0	5	10	15	10	20	2	5	15	15	10	10	27	30	0	15	30	30	30	45	86	125
	Esthetics	15	15	7	15	5	10	27	40	0	10	7	10	7	20	5	5	5	5	5	5	15	15	0	10	10	15	10	25	59	100
Reusable Patient Items	Sanitation		15	10	20	5	25	15	80		15		15		30		20		10		15		45		10		15		25	15	160
	Safety		15	10	20	0	5	10	40		15		5		20		15		5		15		35		10		15		25	10	120
	Security		15	0	5	7	15	7	35		5		15		20		10		15		15		40		10		15		25	7	130
	Esthetics		5	2	5	2	5	4	15		5		5		10		5		5		5		15		5		5		10	4	50
Non-Combustible	Sanitation	2	5	5	10	5	10	12	25	7	15	2	5	9	20	2	5	0	5	3	5	5	15	2	5	30	45	32	50	58	[illegible]
	Safety	10	20	5	15	10	20	25	55	7	15	5	20	12	35	5	10	5	10	7	10	17	30	0	5	13	25	13	30	67	150
	Security	5	10	0	5	7	15	12	30	0	5	5	10	5	15	5	5	10	10	3	5	18	20	0	5	15	15	15	20	50	85
	Esthetics	5	10	2	5	2	5	9	20	2	5	2	5	4	10	5	5	5	5	5	5	15	15	2	5	2	5	4	10	32	55
Garbage (Non-Grindable)	Sanitation	2	5	2	5	7	15	11	25	2	5	15	15	17	20	2	5	2	5	15	15	19	25	5	10	11	15	16	25	63	95
	Safety	1	5	2	5	2	5	5	15	2	5	2	5	4	10	2	5	2	5	5	5	9	15	0	5	7	10	7	15	25	55
	Security	0	5	0	5	2	5	2	15	0	5	5	5	5	10	2	5	5	5	5	5	12	15	0	5	5	5	5	10	24	50
	Esthetics	11	15	2	5	7	10	20	30	2	5	10	10	12	15	2	5	10	10	5	5	17	20	0	15	15	20	15	35	64	100
Food Service Items	Sanitation	2	5	2	5	7	10	11	20	2	5	7	10	9	15	2	5	2	5	3	15	7	25		5		15		20	27	80
	Safety	5	10	5	10	7	10	17	30	2	5	7	10	9	15	2	5	2	5	0	10	4	20		5		10		15	30	80
	Security	0	5	1	5	5	5	6	15	2	5	5	5	7	10	2	5	5	5	2	5	9	15		5		5		10	22	50
	Esthetics	2	5	2	5	3	5	7	15	2	5	2	5	4	10	2	5	5	5	2	5	9	15		5		5		10	20	50
Total	Sanitation	78	135	112	185	91	155	281	475	116	210	124	165	240	375	81	135	54	85	116	165	251	385	42	90	236	350	278	440	1050	1675
	Safety	57	115	64	135	41	85	162	335	38	115	53	110	91	225	63	120	39	70	59	95	161	285	10	55	120	180	130	235	544	1080
	Security	24	80	7	40	96	125	127	245	2	40	68	125	70	165	25	55	100	115	37	60	162	230	2	75	185	210	187	285	546	925
	Esthetics	58	85	29	60	39	65	126	210	15	50	44	65	59	115	23	40	50	55	34	45	107	140	10	55	62	100	72	155	364	620
TOTAL		217	415	212	420	267	430	696	1265	171	415	289	465	460	880	192	350	243	325	246	365	681	1040	64	275	603	840	667	1115	2504	4300

The tabular descriptions of the existing solid waste systems in detention facilities, as reported in Chapter IX, Volume II, are appended in support of the summary contained in Chapter IV of this volume.

TABLE VIII-9 DESCRIPTION OF SOLID WASTE SYSTEM - MIRA LOMA REHABILITATION CENTER AND SHERIFF'S FACILITY

System Components	Types of Waste		
	Soiled Linen	Garbage	Rubbish
Inter-Unit or Inter-Building:			
Internal Transfer	Hand Cart	Sheriff's Truck	Sheriff's Truck
Central Storage	Laundry Sorting Area	Commercial Bins	Commercial Bins
Central Processing or Disposal	Laundry	---	---
Off-Site:			
External Transfer	---	Private Packer Truck	Private Packer Truck
Final Processing and/or Disposal	---	Private Landfill	Private Landfill
TOTAL WASTES PRODUCED			
Avg. Daily Weight	2,174	1,140	810
% of Total	52.7	27.7	19.6

TABLE IX-2 DESCRIPTION OF SOLID WASTE SYSTEM - CENTRAL JAIL

System Components	Types of Waste		
	Soiled Linen	Garbage	Rubbish
Inter-Unit or Inter-Building:			
Internal Transfer	Hand Cart	Hand Cart	Hand Cart
Central Storage	Soiled Linen Room	Refrigerated Storage Room	Commercial Bins
Central Processing or Disposal	---	---	---
Off-Site:			
External Transfer	Sheriff's Truck	Private Truck	Private Packer Truck
Final Processing and/or Disposal	Mira Loma Laundry	Hog Feeding	Private Landfill
TOTAL WASTES PRODUCED			
Avg. Daily Weight	12,000	7,420	4,200
% of Total	50.8	31.5	17.7

TABLE IX-4 DESCRIPTION OF SOLID WASTE SYSTEM - SYBIL BRAND INSTITUTE

System Components	Types of Waste		
	Soiled Linen	Garbage	Rubbish
Inter-Unit or Inter-Building:			
Internal Transfer	Hand Cart	Hand Cart	Hand Cart
Central Storage	Laundry Sorting Area	Commercial Bins	Commercial Bins
Central Processing or Disposal	Laundry	---	---
Off-Site:			
External Transfer	---	Private Truck	Private Packer Truck
Final Processing and/or Disposal	---	Hog Feeding	Private Landfill
TOTAL WASTES PRODUCED			
Avg. Daily Weight	1,756	1,367	1,217
% of Total	40.5	31.5	28.0

TABLE IX-6 DESCRIPTION OF SOLID WASTE SYSTEM - SAN FERNANDO VALLEY JUVENILE HALL

System Components	Types of Waste		
	Soiled Linen	Garbage	Rubbish
Inter-Unit or Inter-Building:			
Internal Transfer	Hand Cart	Hand Cart	Hand Cart
Central Storage	Soiled Linen Room	Area Near Loading Dock	Loading Dock
Central Processing or Disposal	---	---	---
Off-Site:			
External Transfer	Institution Truck	Sheriff's Truck	Institution Truck
Final Processing and/or Disposal	Olive View Laundry	Hog Feeding	Private Landfill
TOTAL WASTES PRODUCED			
Avg. Daily Weight	895	1,300	1,360
% of Total	25.2	36.5	38.3

TABLE IX-8 DESCRIPTION OF SOLID WASTE SYSTEM - HALL OF JUSTICE

System Components	Types of Waste		
	Soiled Linen	Garbage	Rubbish
Inter-Unit or Inter-Building:			
Internal Transfer	Elevator	Elevator	Elevator
Central Storage	Soiled Linen Room	Open Storage Room	Commercial Bins
Central Processing or Disposal	---	---	---
Off-Site:			
External Transfer	Sheriff's Truck	Private Truck	Private Packer Truck
Final Processing and/or Disposal	Mira Loma Laundry	Hog Feeding	Private Landfill
TOTAL WASTES PRODUCED			
Avg. Daily Weight	7,000	4,000	3,036
% of Total	49.9	28.5	21.6

The tabular evaluations of the existing solid waste systems in detention facilities, as reported in Chapter IX, Volume II, are appended in support of the summary contained in Chapter IV of this volume.

TABLE VIII-10 MIRA LOMA REHABILITATION CENTER AND SHERIFF'S FACILITY

NUMERICAL RATING OF DETENTION FACILITY SOLID WASTE SYSTEMS

System Components			Soiled Linen		Garbage		Rubbish		Total		TOTAL	
			Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value
Inter-Unit or Inter-Building System	Internal Transfer	Sanitation	5	25	2	5	5	20	12	50	51	160
		Safety	2	10	3	15	11	15	16	40		
		Security	2	5	2	10	7	15	11	30		
		Esthetics	3	15	2	10	7	15	12	40		
	Central Storage	Sanitation	5	10	3	5	2	5	10	20	130	195
		Safety	2	10	3	5	19	25	24	40		
		Security	5	20	10	10	30	30	45	60		
		Esthetics	10	20	19	25	22	30	51	75		
	Central Processing or Disposal	Sanitation	3	15		20		15	3	50	15	185
		Safety	2	10		20		20	2	50		
		Security	3	15		10		15	3	40		
		Esthetics	7	15		15		15	7	45		
	Total	Sanitation	13	50	5	30	7	40	25	120	196	540
		Safety	6	30	6	40	30	60	42	130		
		Security	10	40	12	30	37	60	59	130		
		Esthetics	20	50	21	50	29	60	70	160		
Off-Site System	External Transfer	Sanitation		20	5	20	1	5	6	45	14	195
		Safety		15	0	15	0	20	0	50		
		Security		15	0	15	0	15	0	45		
		Esthetics		20	5	20	3	15	8	55		
	Final Processing and/or Disposal	Sanitation		30	5	30	3	15	8	75	106	265
		Safety		15	2	5	15	20	17	40		
		Security		25	15	15	25	25	40	65		
		Esthetics		30	22	30	19	25	41	85		
	Total	Sanitation		50	10	50	4	20	14	120	120	460
		Safety		30	2	20	15	40	17	90		
		Security		40	15	30	25	40	40	110		
		Esthetics		50	27	50	22	40	49	140		
	TOTAL	Sanitation	13	100	15	80	11	60	39	240	316	1000
		Safety	6	60	8	60	45	100	59	220		
		Security	10	80	27	60	62	100	99	240		
		Esthetics	20	100	48	100	51	100	119	300		

TABLE IX-3 NUMERICAL RATING OF SOLID WASTE SYSTEM - CENTRAL JAIL

System Components			Soiled Linen		Garbage		Rubbish		Total		TOTAL	
			Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value
Inter-Unit or Inter-Building System	Internal Transfer	Sanitation	13	25	2	5	5	20	20	50	46	160
		Safety	5	10	3	15	3	15	11	40		
		Security	2	5	2	10	3	15	7	30		
		Esthetics	3	15	2	10	3	15	8	40		
	Central Storage	Sanitation	2	10	2	5	1	5	5	20	61	195
		Safety	0	10	1	5	5	25	6	40		
		Security	5	20	5	10	15	30	25	60		
		Esthetics	5	20	5	25	15	30	25	75		
	Central Processing or Disposal	Sanitation		15		20		15		50		185
		Safety		10		20		20		50		
		Security		15		10		15		40		
		Esthetics		15		15		15		45		
	Total	Sanitation	15	50	4	30	6	40	25	120	107	540
		Safety	5	30	4	40	8	60	17	130		
		Security	7	40	7	30	18	60	32	130		
		Esthetics	8	50	7	50	18	60	33	160		
Off-Site System	External Transfer	Sanitation	5	20	5	20	1	5	11	45	41	195
		Safety	3	15	3	15	5	20	11	50		
		Security	3	15	3	15	0	15	6	45		
		Esthetics	5	20	5	20	3	15	13	55		
	Final Processing and/or Disposal	Sanitation	15	30	5	30	3	15	23	75	124	265
		Safety	3	15	1	5	15	20	19	40		
		Security	5	25	3	15	25	25	33	65		
		Esthetics	15	30	15	30	19	25	49	85		
	Total	Sanitation	20	50	10	50	4	20	34	120	165	460
		Safety	6	30	4	20	20	40	30	90		
		Security	8	40	6	30	25	40	39	110		
		Esthetics	20	50	20	50	22	40	62	140		
TOTAL		Sanitation	35	100	14	80	10	60	59	240	272	1000
		Safety	11	60	8	60	28	100	47	220		
		Security	15	80	13	60	43	100	71	240		
		Esthetics	28	100	27	100	40	100	95	300		

TABLE IX-5 NUMERICAL RATING OF SOLID WASTE SYSTEM - SYBIL BRAND INSTITUTE

	System Components		Soiled Linen Def. Value	Soiled Linen Max. Value	Garbage Def. Value	Garbage Max. Value	Rubbish Def. Value	Rubbish Max. Value	Total Def. Value	Total Max. Value	TOTAL Def. Value	TOTAL Max. Value
Inter-Unit or Inter-Building System	Internal Transfer	Sanitation	5	25	2	5	5	20	12	50	39	160
		Safety	2	10	3	15	3	15	8	40		
		Security	2	5	2	10	7	15	11	30		
		Esthetics	3	15	2	10	3	15	8	40		
	Central Storage	Sanitation	2	10	2	5	2	5	6	20	85	195
		Safety	2	10	1	5	13	25	16	40		
		Security	5	20	5	10	15	30	25	60		
		Esthetics	10	20	13	25	15	30	38	75		
	Central Processing or Disposal	Sanitation	3	15		20		15	3	50	15	185
		Safety	2	10		20		20	2	50		
		Security	7	15		10		15	7	40		
		Esthetics	3	15		15		15	3	45		
	Total	Sanitation	10	50	4	30	7	40	21	120	139	540
		Safety	6	30	4	40	16	60	26	130		
		Security	14	40	7	30	22	60	43	130		
		Esthetics	16	50	15	50	18	60	49	160		
Off-Site System	External Transfer	Sanitation		20	5	20	1	5	6	45	17	195
		Safety		15	3	15	0	20	3	50		
		Security		15	0	15	0	15	0	45		
		Esthetics		20	5	20	3	15	8	55		
	Final Processing and/or Disposal	Sanitation		30	5	30	3	15	8	75	86	265
		Safety		15	1	5	15	20	16	40		
		Security		25	3	15	25	25	28	65		
		Esthetics		30	15	30	19	25	34	85		
	Total	Sanitation		50	10	50	4	20	14	120	103	460
		Safety		30	4	20	15	40	19	90		
		Security		40	3	30	25	40	28	110		
		Esthetics		50	20	50	22	40	42	140		
	TOTAL	Sanitation	10	100	14	80	11	60	35	240	242	1000
		Safety	6	60	8	60	31	100	45	220		
		Security	14	80	10	60	47	100	71	240		
		Esthetics	16	100	35	100	40	100	91	300		

TABLE IX-7 NUMERICAL RATING OF SOLID WASTE SYSTEM - SAN FERNANDO VALLEY JUVENILE HALL

System Components			Soiled Linen		Garbage		Rubbish		Total		TOTAL	
			Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value
Inter-Unit or Inter-Building System	Internal Transfer	Sanitation	5	25	2	5	5	20	12	50	35	160
		Safety	2	10	3	15	3	15	8	40		
		Security	2	5	2	10	3	15	7	30		
		Esthetics	3	15	2	10	3	15	8	40		
	Central Storage	Sanitation	2	10	2	5	2	5	6	20	96	195
		Safety	2	10	2	5	13	25	17	40		
		Security	5	20	5	10	15	30	25	60		
		Esthetics	5	20	13	25	30	30	48	75		
	Central Processing or Disposal	Sanitation		15		20		15		50		185
		Safety		10		20		20		50		
		Security		15		10		15		40		
		Esthetics		15		15		15		45		
	Total	Sanitation	7	50	4	30	7	40	18	120	131	540
		Safety	4	30	5	40	16	60	25	130		
		Security	7	40	7	30	18	60	32	130		
		Esthetics	8	50	15	50	33	60	56	160		
Off-Site System	External Transfer	Sanitation	5	20	5	20	2	5	12	45	46	195
		Safety	3	15	3	15	5	20	11	50		
		Security	3	15	3	15	0	15	6	45		
		Esthetics	5	20	5	20	7	15	17	55		
	Final Processing and/or Disposal	Sanitation	15	30	5	30	3	15	23	75	124	265
		Safety	3	15	1	5	15	20	19	40		
		Security	5	25	3	15	25	25	33	65		
		Esthetics	15	30	15	30	19	25	49	85		
	Total	Sanitation	20	50	10	50	5	20	35	120	170	460
		Safety	6	30	4	20	20	40	30	90		
		Security	8	40	6	30	25	40	39	110		
		Esthetics	20	50	20	50	26	40	66	140		
	TOTAL	Sanitation	27	100	14	80	12	60	53	240	301	1000
		Safety	10	60	9	60	36	100	55	220		
		Security	15	80	13	60	43	100	71	240		
		Esthetics	28	100	35	100	59	100	122	300		

TABLE IX-9 NUMERICAL RATING OF SOLID WASTE SYSTEM - HALL OF JUSTICE

System Components			Soiled Linen		Garbage		Rubbish		Total		TOTAL	
			Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value
Inter-Unit or Inter-Building System	Internal Transfer	Sanitation	13	25	2	5	5	20	20	50	46	160
		Safety	5	10	3	15	3	15	11	40		
		Security	2	5	2	10	3	15	7	30		
		Esthetics	3	15	2	10	3	15	8	40		
	Central Storage	Sanitation	5	10	5	5	2	5	12	20	137	195
		Safety	2	10	2	5	13	25	17	40		
		Security	10	20	10	10	30	30	50	60		
		Esthetics	10	20	25	25	23	30	58	75		
	Central Processing or Disposal	Sanitation		15		20		15		50		185
		Safety		10		20		20		50		
		Security		15		10		15		40		
		Esthetics		15		15		15		45		
	Total	Sanitation	18	50	7	30	7	40	32	120	183	540
		Safety	7	30	5	40	16	60	28	130		
		Security	12	40	12	30	33	60	57	130		
		Esthetics	13	50	27	50	26	60	66	160		
Off-Site System	External Transfer	Sanitation	5	20	5	20	1	5	11	45	41	195
		Safety	3	15	3	15	5	20	11	50		
		Security	3	15	3	15	0	15	6	45		
		Esthetics	5	20	5	20	3	15	13	55		
	Final Processing and/or Disposal	Sanitation	15	30	5	30	3	15	23	75	144	265
		Safety	3	15	2	5	15	20	20	40		
		Security	5	25	15	15	25	25	45	65		
		Esthetics	15	30	22	30	19	25	56	85		
	Total	Sanitation	20	50	10	50	4	20	34	120	185	460
		Safety	6	30	5	20	20	40	31	90		
		Security	8	40	18	30	25	40	51	110		
		Esthetics	20	50	27	50	22	40	69	140		
	TOTAL	Sanitation	38	100	17	80	11	60	66	240	368	1000
		Safety	13	60	10	60	36	100	59	220		
		Security	20	80	30	60	58	100	108	240		
		Esthetics	33	100	54	100	48	100	135	300		

The tabular descriptions of the existing solid waste systems in office buildings, as reported in Chapter X, Volume II, are appended in support of the summary contained in Chapter IV of this volume.

TABLE X-3 DESCRIPTION OF OFFICE BUILDING SOLID WASTE SYSTEMS

System Components	Hall of Records	Hall of Administration	County Courthouse	County Engineers
UNIT SYSTEM:				
Initial Deposit (Receiver)	Unlined Cans	Open Container	Open Container	Unlined Cans
Initial Transfer	Manual	Hand Cart	Hand Cart	Manual
Initial Storage, Processing, Disposal	Barrel on Cart	Commercial Bin	Corridor	Barrel on Cart
INTER-UNIT SYSTEM:				
Internal Transfer	Elevator	Elevator	Motorized Cart	Elevator
Central Storage	Trash Room	Loading Dock	Trash Room	Bins in Corridor
Central Processing or Disposal	---	---	---	---
OFF-SITE SYSTEM:				
External Transfer	Packer Truck	Packer Truck	Packer Truck	Packer Truck
Final Processing and/or Disposal	Landfill	Landfill	Landfill	Landfill
DAILY WASTE PRODUCED (Lbs.)	1,000	2,560	1,750	840

The tabular evaluations of the existing solid waste systems in office buildings, as reported in Chapter X, Volume II, are appended in support of the summary contained in Chapter IV of this volume.

TABLE X-7

NUMERICAL RATING OF OFFICE BUILDING SOLID WASTE SYSTEMS

System Components			HALL OF RECORDS				HALL OF ADMINISTRATION				COUNTY COURTHOUSE				ENGINEERS BUILDING			
			RUBBISH		Total		RUBBISH		Total		RUBBISH		Total		RUBBISH		Total	
			Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value
UNIT SYSTEM	Initial Deposit (Receiver)	Sanitation	2	10	9	40	2	10	9	40	2	10	9	40	2	10	9	40
		Safety	1	5			1	5			1	5			1	5		
		Security	1	5			1	5			1	5			1	5		
		Esthetics	5	20			5	20			5	20			5	20		
	Initial Transfer	Sanitation	2	10	5	30	2	10	5	30	2	10	5	30	2	10	5	30
		Safety	1	5			1	5			1	5			1	5		
		Security	0	5			0	5			0	5			0	5		
		Esthetics	2	10			2	10			2	10			2	10		
	Initial Storage, Processing, Disposal	Sanitation	1	5	21	55	1	5	21	55	1	5	26	55	1	5	14	55
		Safety	3	15			3	15			3	15			3	15		
		Security	7	15			7	15			7	15			0	15		
		Esthetics	10	20			10	20			15	20			10	20		
	Total	Sanitation	5	25	35	125	5	25	35	125	5	25	40	125	5	25	28	125
		Safety	5	25			5	25			5	25			5	25		
		Security	8	25			8	25			8	25			1	25		
		Esthetics	17	50			17	50			22	50			17	50		
INTER-UNIT SYSTEM	Internal Transfer	Sanitation	5	25	13	60	5	25	22	60	5	25	21	60	5	25	13	60
		Safety	3	15			7	15			11	15			3	15		
		Security	0	10			5	10			0	10			0	10		
		Esthetics	5	10			5	10			5	10			5	10		
	Central Storage	Sanitation	5	10	23	75	5	10	53	75	5	10	30	75	5	10	70	75
		Safety	5	25			13	25			5	25			25	25		
		Security	8	30			30	30			15	30			30	30		
		Esthetics	5	10			5	10			5	10			10	10		
	Central Processing or Disposal	Sanitation		15		40		15		40		15		40		15		40
		Safety		10				10				10				10		
		Security		10				10				10				10		
		Esthetics		5				5				5				5		
	Total	Sanitation	10	50	36	175	10	50	75	175	10	50	51	175	10	50	83	175
		Safety	8	50			20	50			16	50			28	50		
		Security	8	50			35	50			15	50			30	50		
		Esthetics	10	25			10	25			10	25			15	25		
OFF-SITE SYSTEM	External Transfer	Sanitation	2	10	5	30	2	10	5	30	2	10	8	30	2	10	5	30
		Safety	2	10			2	10			5	10			2	10		
		Security	0	5			0	5			0	5			0	5		
		Esthetics	1	5			1	5			1	5			1	5		
	Final Processing and/or Disposal	Sanitation	3	15	50	70	3	15	50	70	3	15	50	70	3	15	50	70
		Safety	12	15			12	15			12	15			12	15		
		Security	20	20			20	20			20	20			20	20		
		Esthetics	15	20			15	20			15	20			15	20		
	Total	Sanitation	5	25	55	100	5	25	55	100	5	25	58	100	5	25	55	100
		Safety	14	25			14	25			17	25			14	25		
		Security	20	25			20	25			20	25			20	25		
		Esthetics	16	25			16	25			16	25			16	25		
TOTAL		Sanitation	20	100	126	400	20	100	165	400	20	100	149	400	20	100	166	400
		Safety	27	100			39	100			38	100			47	100		
		Security	36	100			63	100			43	100			51	100		
		Esthetics	43	100			43	100			48	100			48	100		

The evaluation of considered improvements to the solid waste system at the LAC-USC Medical Center, as reported in Chapter III, Volume IV, is appended in its entirety. Based upon evaluation methods and system requirements established in earlier stages of this study, considered modifications to the existing system were all centered around a central pneumatic collection system with various processing and disposal options. The following comparisons of these systems further support the selected modifications proposed as the basis for the demonstration project.

LAC-USC MEDICAL CENTER

The evaluation of those system modifications described in the foregoing, and the overall effect of those modifications on the solid waste system operation at the LAC-USC Medical Center are summarized in the following group of illustrations:

Table III-1	Percentage Deficiencies of Sub-System Functions
Figure III-1	Comparison of System Deficiencies
Table III-2	Comparison of Project Costs
Table III-3	Economic Evaluation of Solid Waste System Modifications
Figure III-2	Comparison of Economic Desirability of Systems

Table III-1 shows percentage deficiencies of sub-system functions within each modified system and the comparison to deficiencies of the existing system. Figure III-1 graphically illustrates these comparisons. These illustrations are summarized from the detailed numerical ratings of each modified system included as Appendix B (pages b-1 and b-2). It will be noted that variations in deficiencies of the modified systems occur only in the functions of on-site central processing or disposal and the off-site system. Substantial decreases of present deficiencies in the handling system operation are expected to be accomplished with the pneumatic conveyor system. The remaining deficiencies are largely associated with those reusables (patient and food service items) not entering the modified system, as well as the initial handling of nearly all items in the unit system prior to entering the modified portions of the system. In the case of the latter, further reduction of deficiencies in operation are likely to come about only through enforcement of policies and closer supervision and not through mechanization in the foreseeable future.

Estimated costs of the various systems are illustrated in Table III-2. It will be noted that approximate costs of the pneumatic system are constant in all systems with variations occurring only in the processing and disposal elements. Estimated daily labor costs for each of the modified systems shown in Appendix B (pages b-3, b-4 and b-5) provide detail on classifications of labor distributed to various categories of wastes within the sub-systems. These may be compared to estimated daily labor costs of the existing system (Table II-13, Page II-41, Volume II). Principal economies, occurring in the Unit, Inter-Unit and Inter-Building systems as a direct result of the pneumatic system, are constant in the labor estimates of each modified system. Variations in labor between the modified systems occur only with the differing requirements of processing and disposal methods.

Economic evaluation of the various modified systems is summarized in Table III-3, showing net investment requirements, direct annual operating advantages (gross savings) and indirect or non-operating annual advantages (savings accruing from elimination of certain parts of the existing system). Calculations of the annual return on the investment after depreciation is shown in dollars and the percentage return is expressed as the "desirability rating". Figure III-2 graphically illustrates the comparison of desirability ratings. In comparison between systems, the higher the return, the greater the "economic desirability" of the investment. It is emphasized that this analysis does not consider the cost of funding such improvements and the rate of return (desirability rating) shown should be compared to existing interest rates available and average annual interest rate applicable to the respective investments.

Investment requirements of the four systems considered (systems 1-4) with processing and disposal methods which meet the established criteria range from $1,932,000 to $2,317,000. The indicated annual return on required investments range from 16% to 22%. The range in system improvements indicates the deficiencies of the existing system may be decreased by 58% - 65% with major improvements at nearly all levels of operation.

Comparison of Hospital Solid Waste Systems

LAC-USC Medical Center

TABLE III-1 PERCENTAGE DEFICIENCIES OF SUB-SYSTEM FUNCTIONS

Sub-System and Function	Existing System	Improved Systems			
		System 1	System 2	System 3	System 4
UNIT SYSTEM:					
Initial Deposit	52.3	34.0	34.0	34.0	34.0
Initial Transfer	50.5	34.3	34.3	34.3	34.3
Initial Storage	62.1	25.3	25.3	25.3	25.3
Weighted Average	55.0	31.1	31.1	31.1	31.1
INTER-UNIT SYSTEM:					
Vertical Transfer	41.2	16.6	16.6	16.6	16.6
Intermediate Storage	62.2	21.3	21.3	21.3	21.3
Weighted Average	52.0	19.1	19.1	19.1	19.1
INTER-BUILDING SYSTEM:					
Internal Transfer	54.9	8.3	8.3	8.3	8.3
Central Storage	74.8	31.4	31.4	31.4	31.4
Central Proc. or Disp.	67.4	34.8	47.1	34.8	34.8
Weighted Average	68.0	24.8	29.1	24.8	24.8
OFF-SITE SYSTEM:					
External Transfer	23.3	1.5	1.8	3.3	9.1
Final Proc. or Disp.	71.8	7.1	2.6	20.0	24.3
Weighted Average	60.0	5.7	2.4	15.9	20.5
TOTAL SYSTEM	58.0	20.6	20.8	23.2	24.4
% DECREASE OF DEFICIENCIES	--	64.7	64.3	60.2	58.1

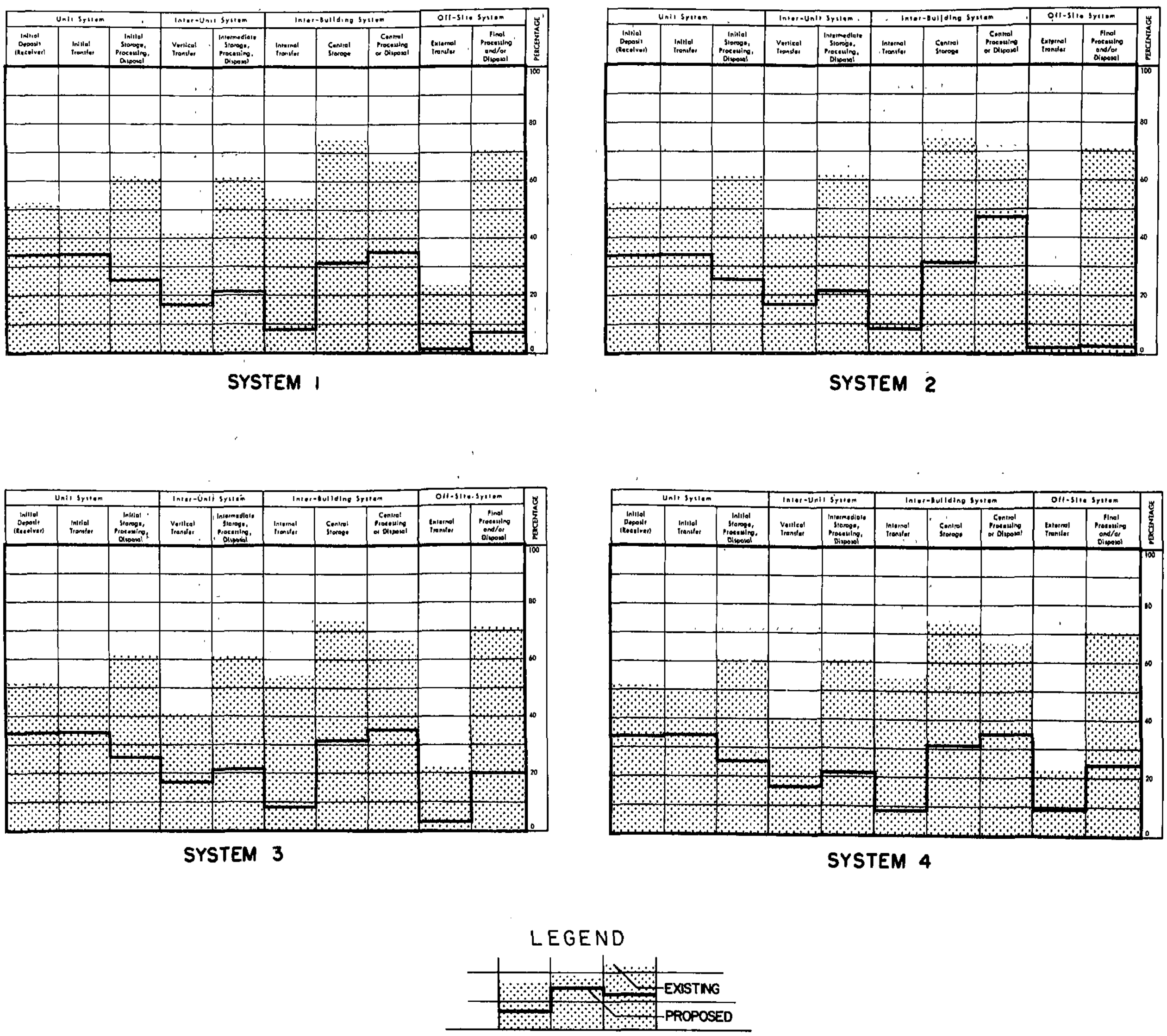


FIGURE III-1 COMPARISON OF SYSTEM DEFICIENCIES

LAC-USC Medical Center

TABLE III-2 COMPARISON OF PROJECT COSTS

LAC-USC Medical Center

SYSTEM	SYSTEM COMPONENT	INSTALLED COSTS	ESTIMATED LIFE (YEARS)	DEPRECIATION
1	Vacuum Tube	$1,600,000	25	$ 64,000
	Grinders	200,000	10	20,000
	Building	210,000	25	8,400
	Wet Oxidation	360,000	25	14,400
	Total	$2,370,000		$106,800
2	Vacuum Tube	$1,600,000	25	$ 64,000
	Incinerator	750,000	25	30,000
	Total	$2,350,000		$ 94,000
3	Vacuum Tube	$1,600,000	25	$ 64,000
	Grinders	200,000	10	20,000
	Building	210,000	25	8,400
	Wet Oxidation	360,000	25	14,400
	Truck	25,000	10	2,500
	Total	$2,395,000		$109,300
4	Vacuum Tube	$1,600,000	25	$ 64,000
	Grinder	200,000	10	20,000
	Building	210,000	25	8,400
	Total	$2,010,000		$ 92,400
5	Vacuum Tube	$1,600,000	25	$ 64,000
	Grinders	200,000	10	20,000
	Building	210,000	25	8,400
	Extruders	90,000	10	9,000
	Truck	25,000	10	2,500
	Total	$2,125,000		$103,900
6	Vacuum Tube	$1,600,000	25	$ 64,000
	Shred	220,000	10	22,000
	Building	210,000	25	8,400
	Truck	25,000	10	2,500
	Total	$2,035,000		$ 96,900
7	Vacuum Tube	$1,600,000	25	$ 64,000
	Grinders	200,000	10	20,000
	Dewater	55,000	10	5,500
	Building	210,000	25	8,400
	Truck	25,000	10	2,500
	Total	$2,090,000		$100,400
8	Vacuum Tube	$1,600,000	25	$ 64,000
	Compactor	30,000	10	3,000
	Containers	24,000	25	1,000
	Building	150,000	25	6,000
	Equipment	75,000	25	3,000
	Total	$1,879,000		$ 77,000
9	Vacuum Tube	$1,600,000	25	$ 64,000
	Trucks	80,000	10	8,000
	Building	150,000	25	6,000
	Equipment	75,000	25	3,000
	Total	$1,905,000		$ 81,000

TABLE III-3 ECONOMIC EVALUATION OF SOLID WASTE SYSTEM MODIFICATIONS

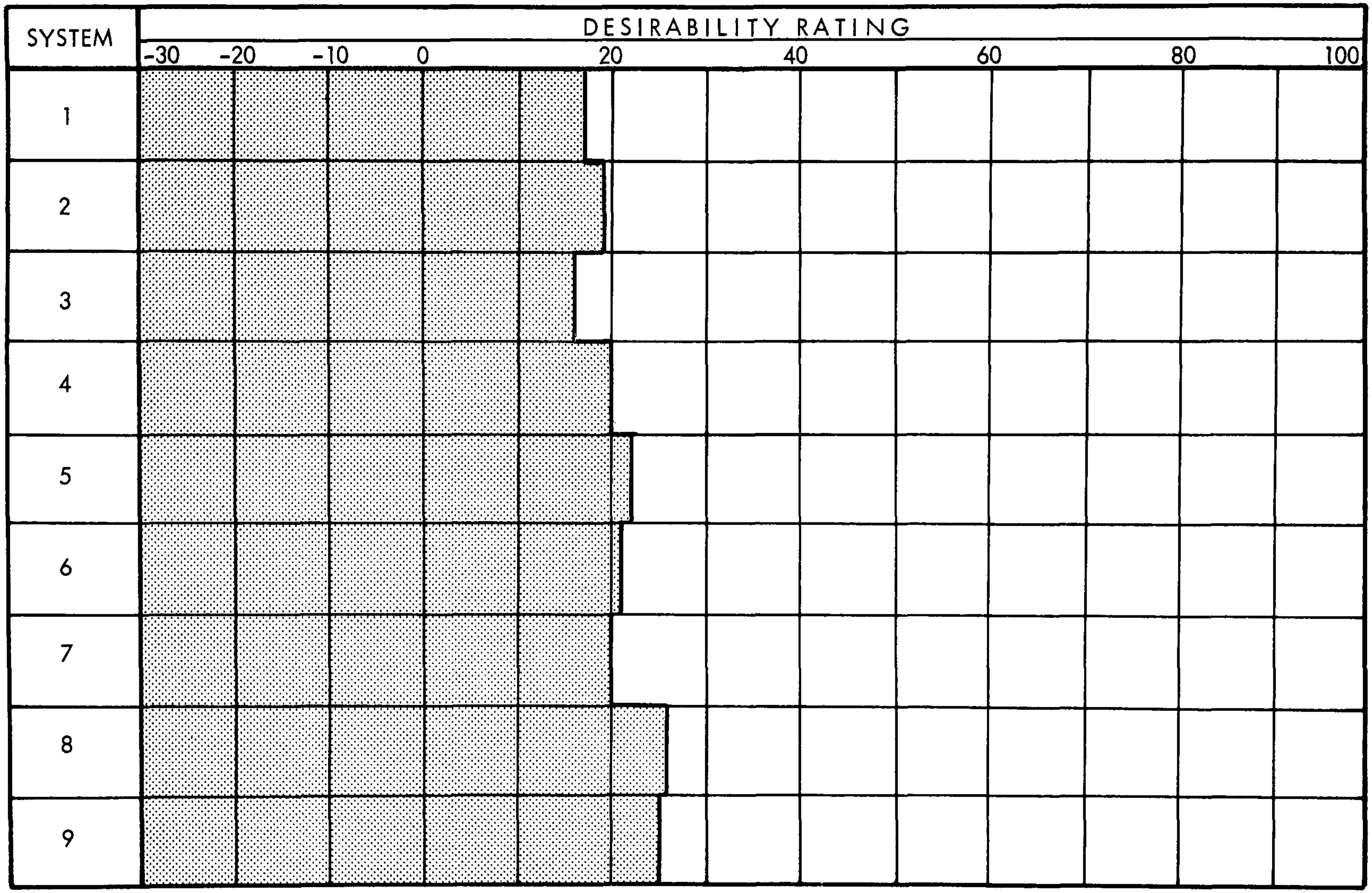
LAC-USC Medical Center

	SYSTEMS																	
	1		2		3		4		5		6		7		8		9	
I INVESTMENT																		
Installed Cost of Project		$2,370,000		$2,350,000		$2,395,000		$2,010,000		$2,125,000		$2,035,000		$2,090,000		$1,879,000		$1,905,000
Disposal Value of Assets Retired by Project	$ 28,000		$ 28,000		$ 28,000		$ 28,000		$ 28,000		$ 28,000		$ 28,000		$ 28,000		$ 28,000	
Capital Additions In Absence of Project	50,000		50,000		50,000		50,000		50,000		50,000		50,000		50,000		50,000	
Investment Released or Avoided by Project		78,000		78,000		78,000		78,000		78,000		78,000		78,000		78,000		78,000
Net Investment Required		$2,292,000		$2,272,000		$2,317,000		$1,932,000		$2,047,000		$1,957,000		$2,012,000		$1,801,000		$1,827,000
II NON-OPERATING ADVANTAGE																		
Decline of Present System Disposal Value	$ 2,800		$ 2,800		$ 2,800		$ 2,800		$ 2,800		$ 2,800		$ 2,800		$ 2,800		$ 2,800	
Depreciation on Capital Additions Avoided	5,000		5,000		5,000		5,000		5,000		5,000		5,000		5,000		5,000	
Total Non-Operating Advantage		$ 7,800		$ 7,800		$ 7,800		$ 7,800		$ 7,800		$ 7,800		$ 7,800		$ 7,800		$ 7,800
III OPERATING ADVANTAGE																		
DIRECT EFFECT OF PROJECT	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease	Increase	Decrease
Labor		$ 541,650		$ 540,000		$ 528,100		$ 541,650		$ 541,650		$ 528,100		$ 528,100		$ 559,000		$ 545,400
Maintenance	$ 3,900		$ 1,175		$ 4,100		$ 2,950		$ 4,400		$ 2,950		$ 3,300		$ 1,000		$ 2,000	
Materials and Supplies	5,000		3,000		5,000		3,500		5,000		5,000		4,000		2,000		2,000	
Power	47,600		24,400		48,700		22,500		31,300		22,500		24,000		18,500		20,000	
Floor Space		$ 3,100		$ 3,100		$ 3,100		$ 3,100		$ 3,100		$ 3,100		$ 3,100		$ 3,100		$ 3,100
Net Increase or Decrease In Operating Costs		$ 488,250		$ 514,525		$ 473,400		$ 515,800		$ 504,050		$ 500,750		$ 499,900		$ 540,600		$ 524,500
IV COMPUTATION OF DESIRABILITY RATING																		
Total Advantage	$496,050		$522,325		$481,200		$523,600		$511,850		$508,550		$507,700		$548,400		$532,300	
Depreciation	106,800		94,000		109,300		92,400		103,900		96,900		100,400		77,000		81,000	
Return on Investment	389,250		428,325		371,900		431,200		407,950		411,650		407,300		471,400		451,300	
Desirability Rating	17		19		16		22		20		21		20		26		25	

Note: Term "Desirability Rating" is synonymous with percent of return on investment.

FIGURE III-2 COMPARISON OF ECONOMIC DESIRABILITY OF SYSTEMS

LAC-USC Medical Center



Note: Term "Desirability Rating" is synonymous with percent of return on investment.

The continuing study of proposed solid waste system improvements at the LAC-USC Medical Center, as reported in Chapter VI, Volume IV, is appended in its entirety. This study covers the development of the design concept, schematic plans, estimated costs of construction and operation, benefits of the system and a proposed testing and observation program after installation of the system.

CHAP. VI PROPOSED PILOT PROJECT

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LIST OF TABLES

LIST OF FIGURES

The earlier volumes of this study have provided a summary of the total study, a detailed study and evaluation of existing waste systems in selected building complexes and an investigation of available equipment for system improvements. In the preceding section of this volume, an evaluation of considered system improvements was made at each of the selected building complexes. Upon review of these evaluations, one of these complexes, the LAC-USC Medical Center, was selected for continuing study and as the site for construction of the recommended system to be tested.

The proposed waste system for this project involves pneumatic transport of disposable wastes and reusable linens employing a single tube pneumatic conveyor system. This proposed system also will contain a central pulping station for disposable materials, a wet oxidation process and an experimental sewage treatment plant. Optional processes and disposal methods available include discharge of raw or sterilized pulped wastes to sewers, transport of dewatered raw or sterilized pulped wastes to landfills, nearly complete oxidation of pulped wastes with discharge of residue to sewers or dewatered residue to landfills or emergency bypassing of all processes with direct discharge of bulk wastes to a compactor for disposal at landfills.

The Medical Center project permits a full range of observations and tests on sterilization of pulped wastes, effects of raw or sterilized pulped wastes on various sewage treatment processes, recovery of cellulose by the wet oxidation process and numerous other activities noted in the scope and objectives of the project.

SCOPE OF PROJECT

The project includes the design, construction and operation of the proposed solid waste system, together with an extensive program of observations, sampling, analysis, and testing. This program will determine the adequacy of each item of equipment to fulfill its function properly and any modifications that may be needed to improve its operation. Careful records of operating and maintenance cost will be maintained and any improvements in related services will be observed to evaluate properly the economic impact resulting from the installation.

Tests will be conducted and observations made to determine the improvement in environmental conditions as related to the handling of waste materials and the disposal of refuse. Microbiological air samples will be taken in the vicinity of laundry and refuse chutes, in service tunnels and at the inlet of the conveying system to determine improvement achieved through the installation of the system. Similar tests will be made on the discharge of the exhaust filters from the conveying system, at the pulping units to determine the level of aerosol contamination at these points, and the need, if any, of modifying these installations. Evaluations will be made on the effectiveness of a single tube pneumatic conveying system for transport of disposable wastes and reusable linen.

Physical inspections will be made of the sewers into which pulped refuse is discharged to determine the condition of the sewers, quantities and type of deposits, septic conditions, etc. both above and at intervals below the point of discharge of pulped waste before commencing such discharge and at intervals during the program.

Measurements will be made of sewage flows above and at intervals below the point of discharge of the pulped waste, together with the quantities of pulped waste discharged into the sewers. Measurements will also be made of the quantities of refuse delivered to the waste processing plant, the volume and weight of non-pulpable wastes removed, the amounts of electric power or other fuel consumed, and the quantities of water required.

Physical, chemical and bacterial analyses will be made periodically on samples of the pulped refuse and sewage samples taken above and at intervals below the point of discharge into the sewer to determine the effect of such discharge on the characteristics of the sewage and to the effect on water reclamation.

Tests, including chemical and bacterial analyses, will be conducted on the wet oxidation process to determine the temperature-pressure-time relationship required to sterilize, to oxidize completely or to oxidize sufficiently to permit the recovery of cellulose fiber from varying concentrations of pulped refuse or from varying mixtures of pulped refuse and sewage sludge as would be encountered in a municipal sewerage system if pulped solid waste were admitted on a general or restricted basis.

Tests will be conducted on the stability of the dewatered cake from the wet oxidation process, extent of the reduction of solids and upon the feasibility of recovery of a useable cellulose fiber. Tests will also be conducted on the amenability of the filtrate to conventional sewage treatment processes, either alone or mixed with varying amounts of domestic sewage and on the amenability of various mixtures of pulped refuse and sewage to treatment by conventional or other means.

PROJECT OBJECTIVES

Broadly, the objectives of this program are to develop operating procedures and performance standards and determine operational reliability of the designed system, together with an evaluation of the environmental improvements and economic benefits that may be derived from such projects. These objectives are further expanded as follows:

1. To demonstrate the savings in cost and improvement in environmental conditions in a hospital complex through the installation of a pneumatic conveying system for handling soiled and contaminated materials from hospital floors.

2. To demonstrate the practicality of using sewage as the fluid for pulping and transportation of pulped hospital wastes, and to determine what preconditioning of the sewage, if any, is needed before use in the pulper.

3. To demonstrate the practicality and costs of disposing of pulped hospital wastes in a sanitary sewerage system and the savings in cost thereby.

4. To determine the extent of wet oxidation required and the costs of such processes to sterilize effectively a pulped contaminated hospital waste.

5. To determine the effect of wet oxidation of pulped hospital wastes and the effect of residue discharged into sanitary sewerage systems.

6. To determine the extent of wet oxidation necessary to produce a stable and sterile dewatered pulp and to determine the costs of such processes.

7. To determine the extent of wet oxidation necessary to recover a useable cellulose pulp from pulped hospital waste and the costs of such processes, as well as the practicality of recovering a commercially valuable cellulose pulp from a mixed sewage sludge and pulped waste as might be obtained from the general discharge of pulped solid wastes into the sanitary sewerage system.

8. To determine the quantities and characteristics of non-pulpable hospital wastes and processing required for their safe and proper disposal, as well as the cost.

9. To determine the effect of adding various quantities of pulped solid waste to sanitary sewage on both the primary and secondary units of conventional sewage treatment plants, including those employing both trickling filters and activated sludge or some of its more recent modifications.

10. To determine the effect of adding various quantities of pulped solid waste to sanitary sewage on sludge characteristics, including dewaterability and degradability under both mesophilic and thermophilic anaerobic conditions, as well as under aerobic conditions.

11. To determine the practicability of aerobic decomposition of dewatered pulped waste and sewage sludge through composting.

12. To determine what process or series of processes may be required to treat effectively the mixtures of sanitary sewage and pulped solid waste which might be anticipated in municipal sewerage systems should pulping of such wastes be generally adopted.

13. To evaluate the overall economic and environmental effects on a municipality from the general adoption of pulping as a method of solid waste disposal or of limiting it to contaminated hospital wastes.

14. To continue research on systems and equipment available for materials handling and solid waste disposal to take advantage of development work currently in progress.

15. To continue research on regulatory codes and restrictions and develop code modifications or guidelines for system design as may be required.

16. To provide documentation of project for educational purposes, such as photographic coverage, movies, other visual aids.

CONSTRUCTION PROGRAM

The construction program required for development of this solid waste system is estimated to be completed within the first year's period. Proposed construction of the basic components in this system that is necessary to carry out the project objectives is identified as follows:

1. A single tube pneumatic conveyor system for the collection of both soiled linens and refuse from the various treatment, service and housing units.

2. A central pulping station with discharge to sewers and optional disposal processes.

3. A wet oxidation plant for the oxidation and sterilization of the pulped contaminated waste.

4. A sewage pumping station to supply sewage to the pulpers.

5. A centrifuge or vacuum filter for dewatering oxidized pulp.

6. Experimental sewage treatment plant with capacity of 40,000 $\pm$ gpd and capable of treating various mixtures of pulped waste and sewage by both conventional and non-conventional means.

7. Laboratory and auxiliary equipment required for the operation of the system and carrying out the project objectives.

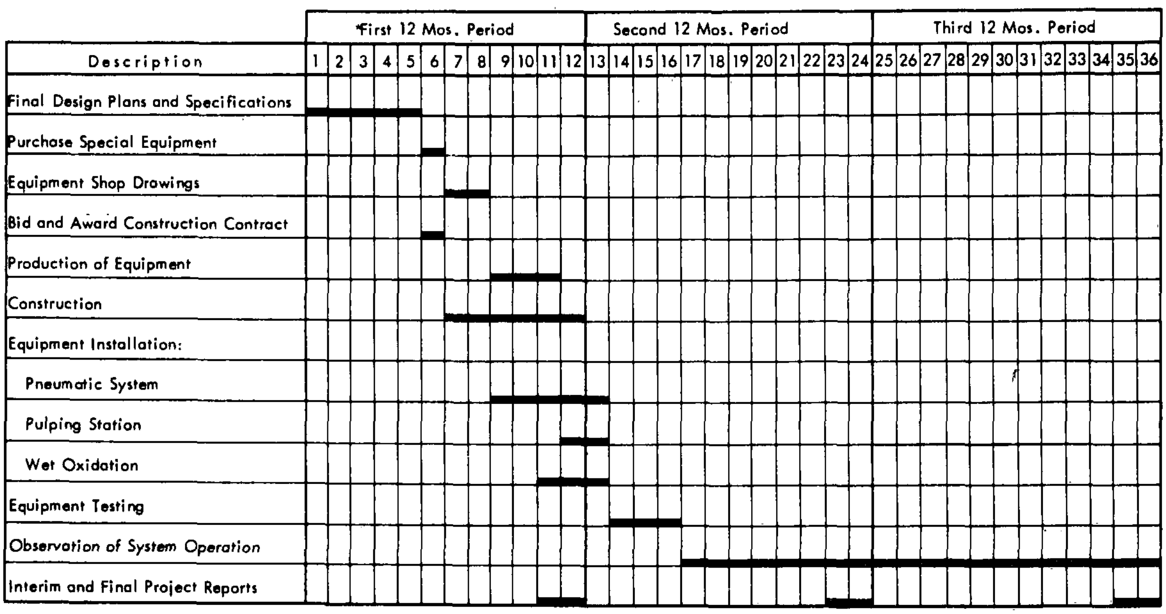
IMPLEMENTATION SCHEDULE

The proposed program is planned over a three-year period. Progress made during preliminary planning indicates it is entirely feasible to expect final design plans and specifications on these projects to be completed during the first six-month period and construction to be accomplished during the remaining portion of the first year. It is also feasible that certain phases of mechanical design of special equipment components can be accelerated in order that their production and delivery for installation will coincide with the construction schedule.

It is anticipated that a period of three to four months during the second year should be allowed for equipment testing and a transition period at the Medical Center project, before full operation should be expected. Within the proposed three-year program, an estimated period of approximately the final twenty months will be available for detailed observations, testing and systems evaluation under full operating conditions. This would appear as a reasonable period in which to accomplish the ultimate objectives of the proposed project.

This proposed implementation schedule is graphically illustrated in Figure VI-1, which details principal items occurring during the program period.

FIGURE VI-1 ESTIMATED SCHEDULE OF THE CONTINUING PROGRAM



*Division of first period into separate Design and Construction Phases will likely extend these activities by approximately 90 days.

DESIGN CONCEPT

During the course of this study, from the evaluation of existing solid waste systems and considered improvements to these systems, the broad concept of a closed mechanical system, fully automated, capable of transporting all disposable and reusable waste materials and providing on-site disposal, appeared to be the optimum system. With the preceding studies, it also became apparent that varying limitations in each of the building complexes investigated would require certain compromises on system selection due to space limitations and existing area functions.

Combined evaluation of the economic and environmental aspects of various combinations of equipment indicated the optimum system for the LAC-USC Medical Center should be designed around a pneumatic transport system for the transport of soiled linens and disposable wastes, together with a central pulping station for processing disposable materials. These new system components or sub-systems would fully replace the present inter-building system and off-site system. Modifications of certain methods and equipment in the inter-unit system would also be required and collectively, these modifications would have a limited effect on methods and practices used in the unit system (patient care and service areas).

Personnel requirements of the improved system would generally be limited to the unit system, where emphasis on handling techniques and supervision could be confined to those initial handling functions prior to deposit of wastes in chutes. Those personnel involved in the mechanical system would be limited to qualified maintenance mechanics and operator classifications.

Local authorities in various County and City agencies concerned with environmental control approved of the basic concept. However, as design criteria were developed and the potential loading and characteristics of solids in the sewerage system became more apparent, concern was expressed about these factors and their ultimate effect on sewage treatment processes. It was recommended that the proposed basic waste system project be expanded to include an experimental sewage treatment plant and sludge processing (wet oxidation) unit, to provide facilities for on-site experimentation in order to evaluate fully the total disposal process.

Preliminary plans were developed around this total concept. Although a substantial investment will be required for the basic solid waste system, anticipated annual savings in the operation of the improved new system would return the investment in a period of five to seven years excluding costs of the experimental sewage treatment plant. If depreciated over a nominal 25-year period, an annual direct savings or operating surplus (over present costs) of about $354,000 would be available for redistribution to patient-care functions or other needed improvements. In addition to these direct savings, it is estimated that substantial indirect benefits though difficult to estimate would likely accrue as a result of improved health and safety standards, both in the hospital plant and the community at large.

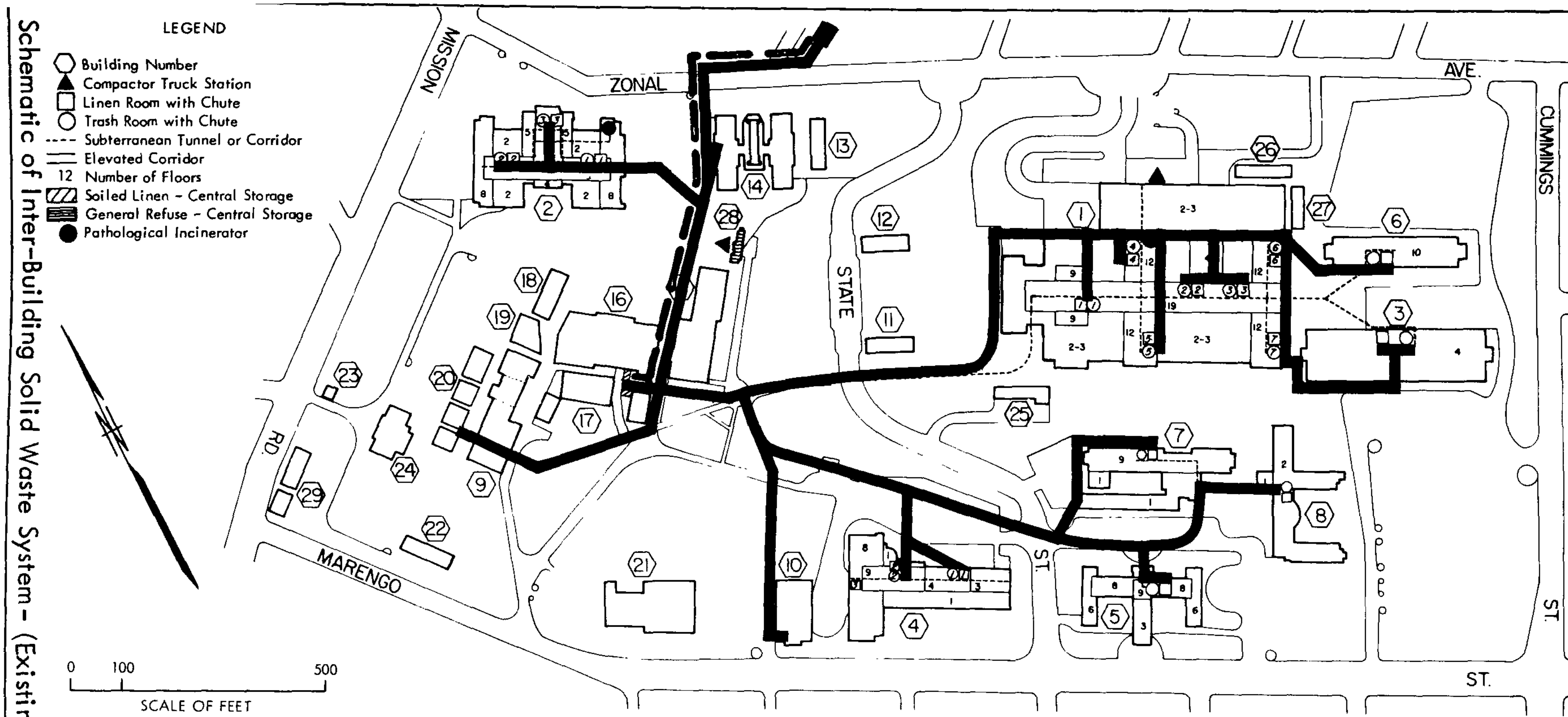
PRELIMINARY PLANS

The above briefly summarizes certain of the background material preceding the preliminary design phase of the proposed system. To reorient the readers to the physical plant at LAC-USC Medical Center, Figure VI-2 illustrates the existing building layout and relates certain features of the existing solid waste system. The schematic routing of the proposed pneumatic conveyor system has been superimposed on this plan showing the approximate piping network that would be situated on the main hospital parcel. The extension of this pipeline across Zonal Avenue terminates at the proposed location of the waste processing plant. This site was selected as the most suitable location for the plant by hospital representatives and their master planning consultant. Figure VI-4 suggests configuration of the plant facilities.

Implementation of the proposed solid waste system will involve construction of a permanent new building to accommodate equipment installations, the control room, office and laboratory services which comprise the central waste processing plant and accessory structures and assemblies. Structures of the experimental sewage plant will be located adjacent to the waste processing plant.

This basic plant as proposed and illustrated in Figures VI-3 and VI-4 will accommodate the pneumatic system discharge hoppers, exhaustors and bacteriological filters, a twin pulper installation with provisions for the addition of a third unit, the wet oxidation equipment, conveying equipment and other accessories to these various processes. In addition, a control room for the pneumatic system, conveying equipment, pulping process and wet oxidation process, together with an office, laboratory and employee facilities are located on the upper floor level with access provided by both elevator and stairs. Contaminated areas within the plant are confined to the

Schematic of Inter-Building Solid Waste System- (Existing)



BUILDING SCHEDULE

Bldg. No.	Function	No. Floors	Area (SF)
1	Unit I - Acute	19	1,285,000
2	Unit II - O.B. & Gyn.	9	376,110
3	Outpatients	4	209,000
4	Pediatrics & C.D.	8	171,075
5	Psychiatric	9	132,000
6	Interns Residence	10	139,000
7	Nurses Res. & Classrooms	9	171,620
8	Nurses Residence	2	46,000
9	Pharmacy	6	55,000
10	General Laboratory	3	33,000
11	Chaplain	1	2,750
12	Patient Identification	1	2,725
13	Research Building	1	22,000
14	Clinical Research	4	61,000
15	Power House	-	--
16	Laundry	2	55,200
17	Shops	1	12,200
18	Research Building	3	14,500
19	Garage	2	6,160
20	Storage	1	4,100
21	Steam Plant	-	--
22	Cancer Research	2	10,200
23	Gate House	1	2,400
24	Admin. (Hosp. Dept.)	4	30,600
25	Telephone Exchange	2	6,180
26	Storage	1	2,940
27	Storage	1	2,270
28	Incinerator	-	--
29	Classrooms	1	2,000

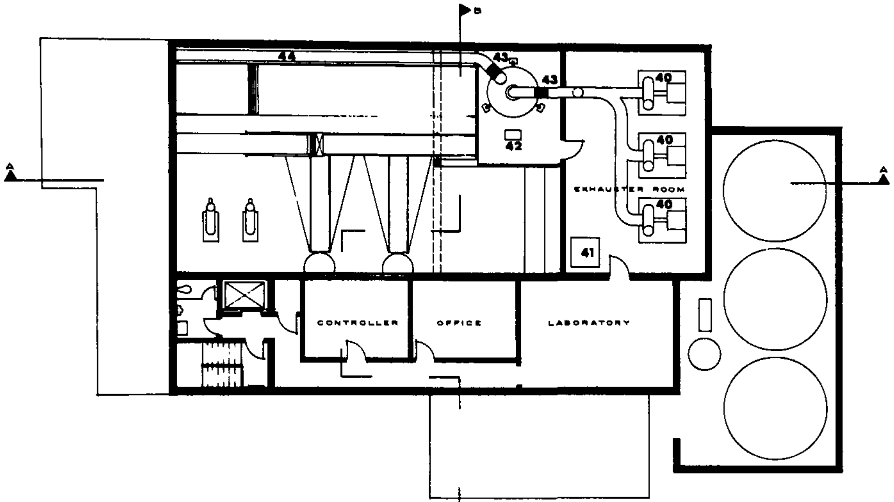
FIGURE VI-2

SCHEMATIC OF PROPOSED INTER-BUILDING COLLECTION SYSTEM AND CENTRAL DISPOSAL PLANT

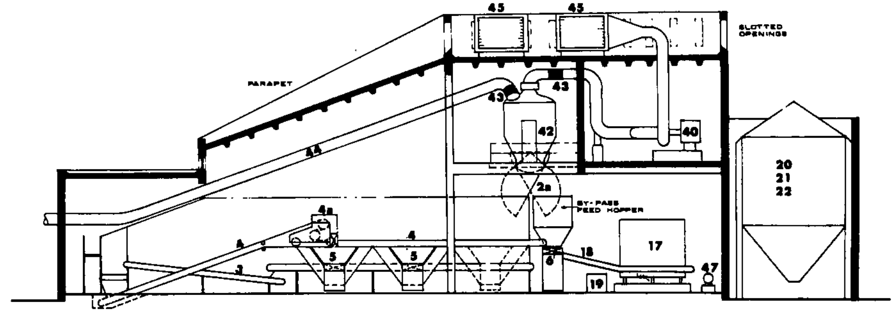
PNEUMATIC TUBE

EXHAUST AIR TUBE

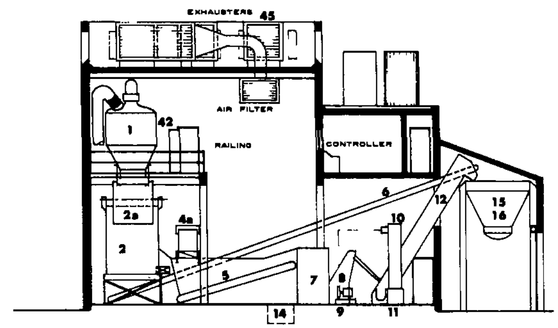
CENTRAL DISPOSAL PLANT



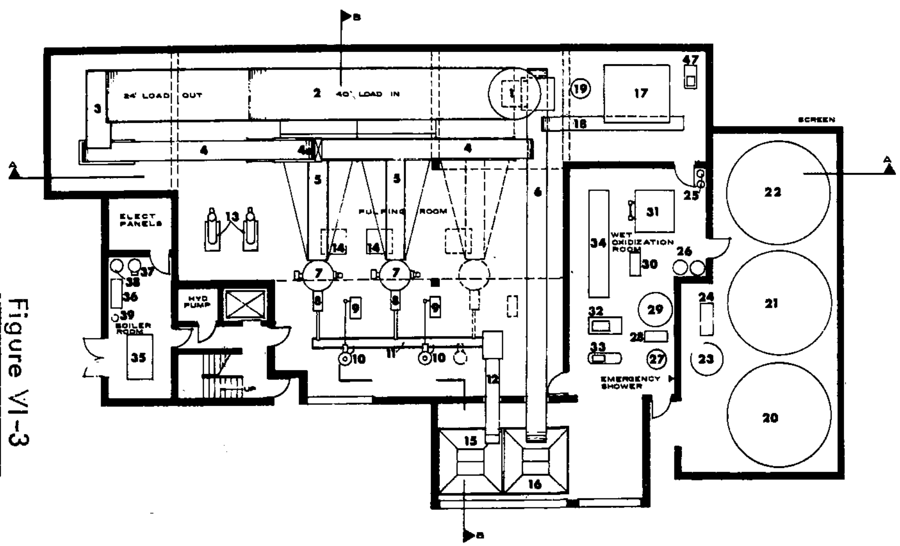
SECOND FLOOR PLAN



SECTION A-A



SECTION B-B



FIRST FLOOR PLAN

SCALE IN FEET 0 5 10 20

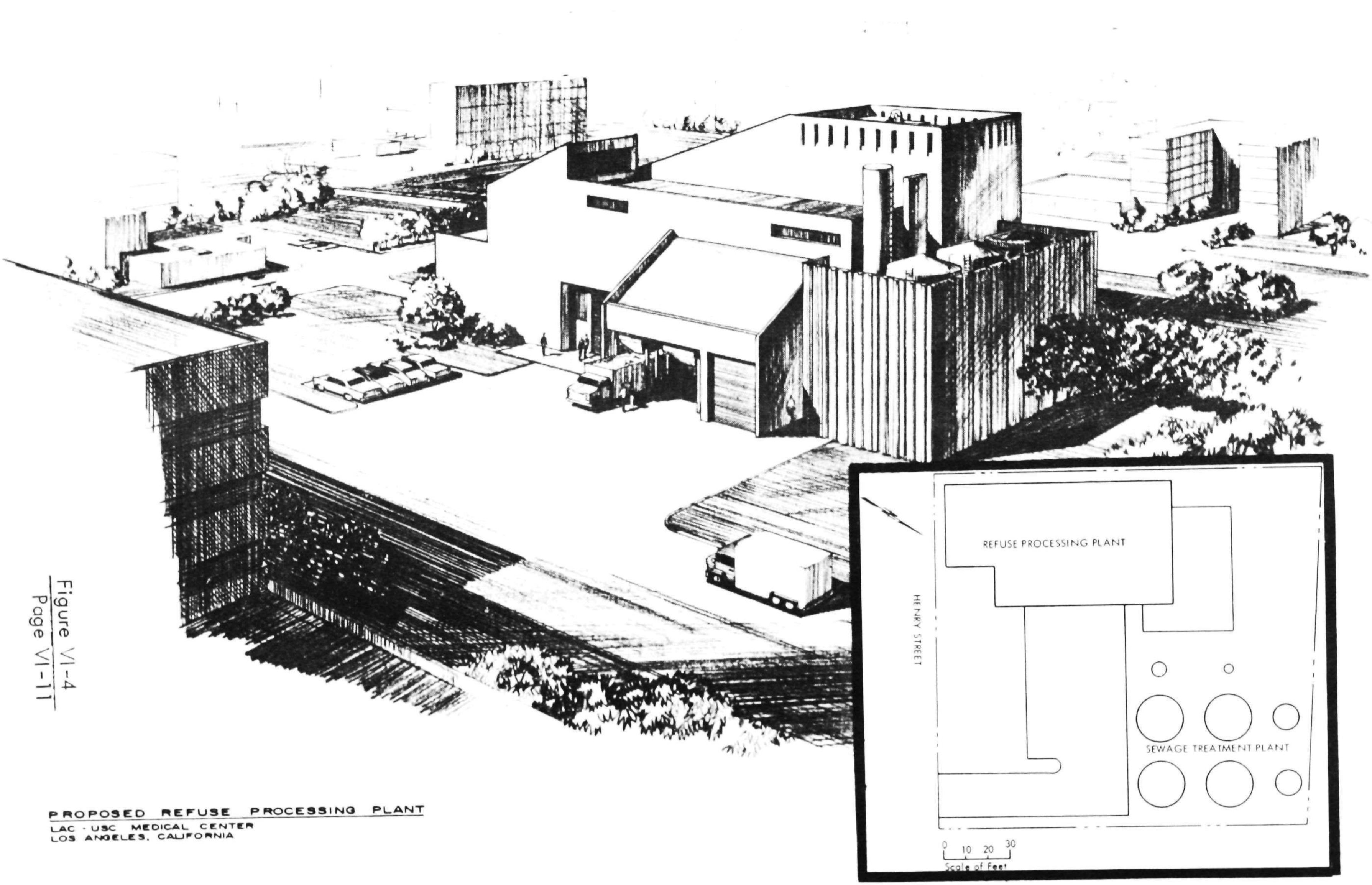
LEGEND

VACUUM SYSTEM DELIVERY HOPPER WITH PNEUMATICALLY OPERATED DISCHARGE GATE
2. STORAGE BIN WITH LIVE BOTTOM (PAN CONVEYORS)
2a PNEUMATICALLY OPERATED BYPASS GATE
3. OSCILLATING CONVEYOR TO LEVEL OUT LOAD
4 BELT CONVEYOR
4a BELT TRIPPER
5. PULPER FEED STORAGE BIN AND CONVEYOR
6 BELT CONVEYOR
7 60" PULPER
8 JUNK SEPARATOR AND ELEVATOR
9. CYCLONE FEED PUMP
10. HYDRAULIC CYCLONE FOR GRIT REMOVAL
11 SCREW CONVEYOR FOR GRIT AND JUNK TRANSFER
12 BUCKET CONVEYOR FOR GRIT AND JUNK
13 SINGLE SCREW THICKENER
14 PULPED REFUSE SUMP
15. GRIT AND JUNK STORAGE HOPPER WITH BOTTOM GATE
16. PROCESSED REFUSE STORAGE HOPPER WITH BOTTOM GATE
17 VACUUM FILTER
18. BELT CONVEYOR
19 MIXING CHAMBER
20 SEWAGE STORAGE AND SETTLING TANK
21 PULPED WASTE STORAGE TANK
22 OXIDIZED WASTE STORAGE TANK
23 REACTOR
24 HEAT EXCHANGER
25 LEVEL CONTROL VALVES
26 COOLERS
27 SEPARATOR
28 SOLVENT PUMP
29. SOLVENT TANK
30 SLUDGE FEED PUMP
31 HIGH PRESSURE SLUDGE PUMP
32. HYDRAULIC PUMP AND STORAGE TANK
33. SERVICE AIR COMPRESSOR AND STORAGE TANK
34. HIGH PRESSURE AIR COMPRESSOR
35. HIGH PRESSURE STEAM BOILER
36 BOILER HEAD TANK
37 CHEMICAL FEED FOR BOILER WATER
38. BRINE TANK
39 WATER SOFTENER
40. VACUUM SYSTEM CENTRIFUGAL EXHAUSTERS
41. VACUUM PUMPS FOR VACUUM FILTER
42 RECORDING SCALE TO WEIGH INCOMING REFUSE
43 FLEXIBLE DUCT CONNECTION TO PERMIT WEIGHING INCOMING REFUSE
44. REFUSE DELIVERY TUBE
45 VACUUM SYSTEM EXHAUST
46 VACUUM PUMP DISCHARGE SILENCER
47. SLUDGE PUMP

PROPOSED REFUSE PROCESSING PLANT
LAC-USC MEDICAL CENTER
LOS ANGELES, CALIFORNIA

ESCO - GREENLEAF
1157 W WASHINGTON BLVD
LOS ANGELES, CALIFORNIA

Figure VI-3



PROPOSED REFUSE PROCESSING PLANT
LAC - USC MEDICAL CENTER
LOS ANGELES, CALIFORNIA

Figure VI-4

central storage and pulping process areas located on the lower level. Dense and inert materials removed by the dejunkers during the pulping process and grit removed by the hydraulic cyclones after pulping are washed and disinfected as they are conveyed to an exterior storage hopper in a screened enclosure. A second hopper in this same area provides storage of the sterile sludge cake after dewatering, or in emergencies (processing breakdown), unprocessed bulk wastes can be directly bypassed to the hopper for evacuation from the plant by compactor trucks.

DESCRIPTION OF THE SYSTEM OPERATION

The pneumatic conveyor system will provide transport service for accumulations of disposable wastes and soiled linen from forty-four loading stations on service levels. These stations include all existing gravity chutes and selected new loading stations.

The piping network required for connection of these stations to the laundry and disposal plant involves about 8,300 lineal feet of 20" diameter 1/4" steel pipe with flanged joints and epoxy lining. In addition to this basic transmission line, special discharge valves and valved air intake piping will serve each loading station.

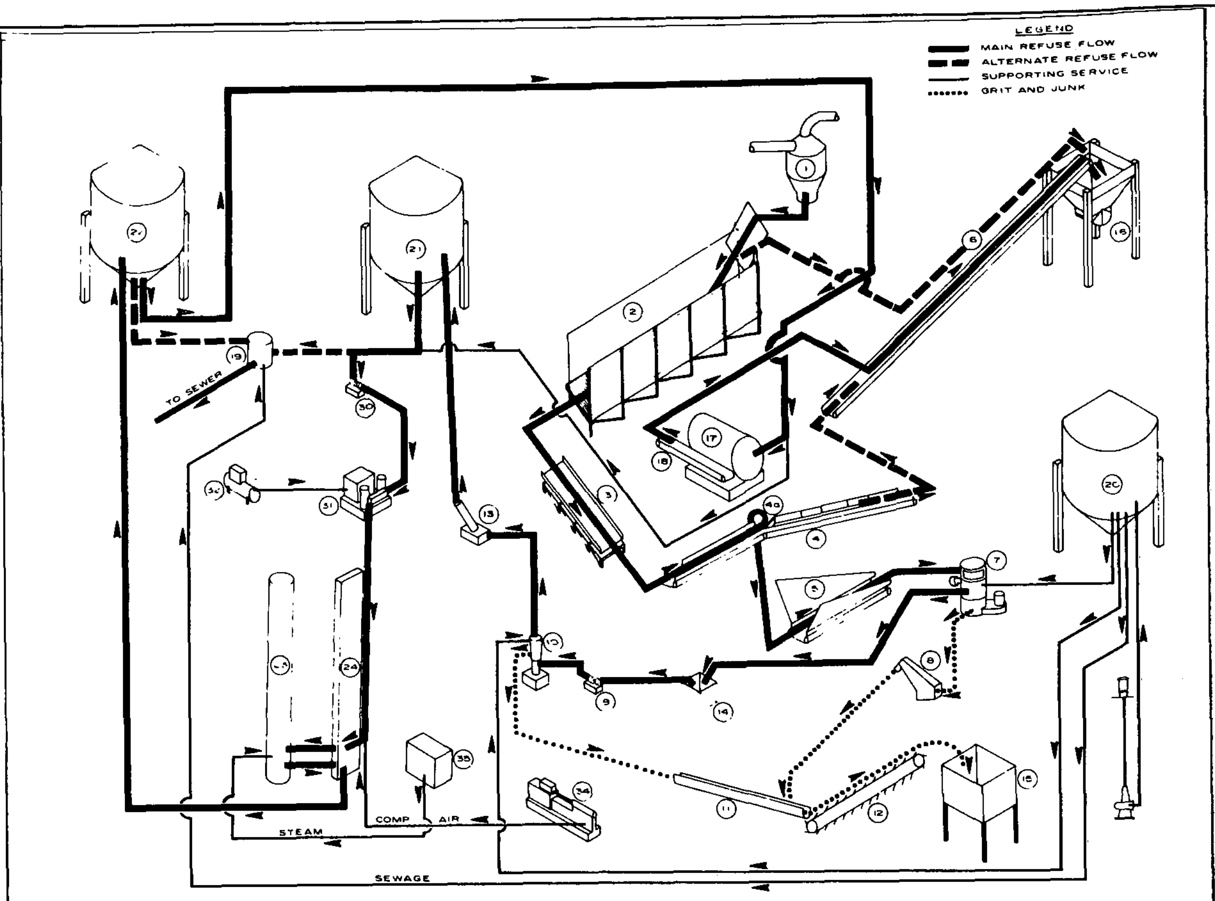
The system will operate on a time and/or demand basis, cycling disposable wastes and soiled linens alternately or as required. Exhaust air will be moved at a rate of about 10,000 cfm or 60 mph by 2-100 HP exhausters with a third 100 HP unit as standby. Evacuated materials will be deposited in collection hoppers at the waste processing plant and the laundry.

Each of the existing chutes will be under induced negative pressure by exhausting air at the rate of about 300 cfm. It is proposed to bleed off this volume continuously into the main transmission line and ultimately through the bacteriological filters at the waste processing plant.

Operation of the waste system (pneumatic conveyors and waste processing plant) will be largely automated. Monitoring devices and required manual override controls for all mechanical elements of the system will be housed in the central control room at the processing plant. A remote monitoring panel with alarm signal systems should be located by plant management as a supplementary control station to insure prompt and proper attention is given to operational malfunctions of the system.

Figure VI-5, a schematic flow diagram, illustrates the various processing functions and sequence of processes that are available in the proposed waste processing plant and identifies the principal equipment components contained therein or adjacent to the structure. This chart shows the flow of refuse through the various units from the pneumatic hopper No. 1, where it is weighed to storage hopper No. 16, where the material is transferred to trucks for disposal at landfills. Refuse material is discharged from receiving hopper No. 1 into storage hopper No. 2, where storage up to a full day's capacity is provided. This central storage hopper is equipped with a live bottom slat conveyor which feeds the waste material to conveyor No. 3. Oscillating conveyor No. 3 is provided to even out the load and the rate of feed to conveyor No. 4, which in turn delivers the refuse to pulper feed bins No. 5. The rate of feed from these bins can be adjusted to the rate at which the materials are being pulped in unit No. 7. Pulped material with about a 3% concentration of solids is delivered by gravity to sump No. 14, from which it in turn is pumped to the degritting unit No. 10, where ground glass, grit and bits of metal are separated from the pulp. The pulp then continues to concentrator No. 13, where sufficient water is removed to give an 8 to 10% consistency of pulp. This pulp is then delivered to storage tank No. 21. From tank No. 21, the pulp enters the wet oxidation system through sludge pump No. 30 and high pressure pump No. 31. It first passes through the heat exchanger No. 24, where it is heated by previously processed pulp before entering the reactor No. 23. In reactor No. 23, it is mixed with steam and compressed air and the material oxidized. From here it returns through the heat exchanger, where much of the heat is given up to the incoming material after which it passes to storage tank No. 22. From storage tank No. 22, the material is dewatered on vacuum filter No. 17 and then delivered via conveyors No. 18 and 6 to the storage hopper No. 16 for truck loading. Unpulpable material is removed from the pulping machine by junker No. 8 and from degritter and fed through conveyors No. 11 and 12 to the grit storage hopper No. 15. Here the material, after disinfection, will be loaded into trucks for disposal at landfills.

The layout of the plant will permit discharging a mixture of either sterilized or unsterilized pulp with sewage to the sewer system or to the experimental sewage treatment plant for further processing. Sewage for the operation of the plant and for the dilution of the pulped material before discharge into the sewerage system



DIAGRAMMATIC CHART — REFUSE PROCESSING PLANT

LEGEND

1. Vacuum system delivery hopper with pneumatically operated discharge gate.
2. Storage bin with live bottom (pan conveyor).
2a. Pneumatically operated bypass gate.
3. Oscillating conveyor to level out load.
4. Belt conveyor.
4a. Pneumatically operated deflector plate.
5. Pulper feed storage bin and conveyor.
6. Belt conveyor.
7. 60" pulper.
8. Junk separator and elevator.
9. Cyclone feed pump.
10. Hydraulic cyclone for grit removal.
11. Screw conveyor for grit and junk transfer.
12. Bucket conveyor for grit and junk.
13. Single screw thickener.
14. Pulped refuse sump.
15. Grit and junk storage hopper with bottom gate.
16. Processed refuse storage hopper with bottom gate.
17. Vacuum filter.
18. Belt conveyor.
19. Mixing chamber.
20. Sewage storage and settling tank.
21. Pulped waste storage tank.
22. Oxidized waste storage tank.
23. Reactor.
24. Heat exchanger.
25. Level control valves.
26. Coolers.
27. Separator.
28. Solvent pump.
29. Solvent tank.
30. Sludge feed pump.
31. High pressure sludge pump.
32. Hydraulic pump and storage tank.
33. Service air compressor and storage tank.
34. High pressure air compressor.
35. High pressure steam boiler.
36. Boiler head tank.
37. Chemical feed for boiler water.
38. Brine tank.
39. Water softener.
40. Vacuum system centrifugal exhausters.
41. Vacuum pumps for vacuum filter.
42. Recording scale to weigh incoming refuse.
43. Flexible duct connection to permit weighing incoming refuse.
44. Refuse delivery tube.
45. Vacuum system exhaust.
46. Vacuum pump discharge silencer.

Figure VI-5

will be taken from the City of Los Angeles sewer system by a small pumping station and pumped to storage tank No. 20, from which it will be used as needed. Sewage from this tank will also be used to feed the experimental sewage treatment plant.

The refuse storage and processing area has been laid out having in mind that this material is contaminated. Operations of this equipment will be controlled from a console in the control room on the second floor and it will not be necessary to have an operator in the refuse or pulping area during its operation.

Accessory equipment, such as flushing and/or steam cleaning devices will be provided for sanitizing processing, storage and conveyor equipment and work areas after daily use. A drainage system will carry off flushings to a sump for discharge to sewers.

Exhaustors for the vacuum collection system are located on the second floor along with the vacuum pump required for the operation of the vacuum filter. The discharge of these exhaustors is through filters located on the roof. These filters will be of a type capable of filtering out bacteria and will be arranged so that they may be sterilized prior to removal for cleaning. Air within the refuse storage and pulping area will be similarly filtered before discharge into the atmosphere.

Design provisions must be made for odor control within the processing plant and to reduce excessive noise to acceptable levels within and outside the plant.

OPERATING CHARACTERISTICS - Wet Pulping System

Principal components of the wet pulping system include two pulpers with junk separators and elevators, two cyclone feed pumps, two degritters and two concentrators. The system shall be capable of pumping the slurry through at least 150 feet of pipe and elevating the slurry by at least 15 feet.

Each pulper shall be capable of processing 12,000 pounds per day of a mixture Class I waste, Class IA waste, and Class II waste, as specified in Table VI-1. The pulpers shall accept unselected waste in loose form, bagged, or in cartons, of any size with the limitation that the longest dimension shall not exceed 36 inches.

The pulper shall reduce the major portion of the waste to a slurry. Pulped particle dimensions shall meet provisions of the City of Los Angeles Bureau of Sanitation Fineness of Grind Specification for Garbage Grinders. The remainder of the waste not slurried shall be ejected by the junk separator.

The pulper shall expel essentially nonpulpables (Class II waste, some Class IA waste and Class IV wastes) through the separators. Such rejects shall initially contain a maximum of 10% by weight (dry basis) of pulpables, which shall be flushed out prior to these rejects being discharged to the conveyor system. Nonpulpables shall be removed and conveyed by the bucket elevator while the pulper is in operation.

Unprocessed waste remaining in the pulper at the end of any given day's operation shall be processed within 30 minutes. After pumpdown and cleaning, residue of non-pulpable materials remaining in the pulper shall not impair the efficiency of the system when it is restarted. It shall not be necessary to remove waste manually from the pulper for trouble-free restart.

The water level in the pulper tank shall be automatically controlled. There shall also be a provision to meter a disinfectant solution automatically into the system through the water makeup line.

Each pulper shall have a rated capacity of processing 12,000 pounds of hospital waste in a five hour period when fed at a continuous uniform rate a mixture of 90% Class I waste and 10% Class II waste. Controls provided shall include automatic start-stop and manual start-stop.

TABLE VI-1 SOLID WASTE CLASSIFICATION

	PULPABLE	NONPULPABLE
NORMALLY PROCESSABLE BY PULPER SYSTEM	CLASS I WASTE* Mixtures, consisting of: Paper products Plastic and rubber tubing Disposable plastic and rubber items Disposable aluminum cookware, dinnerware and foil Cloth or nonwoven fabrics, i.e. clothing, bed linen, towels, gowns, surgical garments, garbage and bones (cooked and uncooked), mop heads, rope, string and tape Wooden vegetable, fruit, poultry and meat crates Plastic casts Animal wastes and bedding CLASS IA WASTE* Glass, sand, ceramic, grit	CLASS II WASTE* Mixtures, consisting of: Metal cans and caps Silverware and utensils Surgical instruments Nails, screws, bolts, clips and other fasteners
NON-PROCESSABLE BY PULPER SYSTEM	CLASS III WASTE Autopsy waste** Pathogenic waste** Isolation area waste** Grease, oils and wax	CLASS IV WASTE Metal surgical appliances Pipe and pipe fittings Metal hardware and other similar objects Bedpans, urinals, pails, and other stainless steel wares Coat hangers, metal wire, and strapping Building material waste including: bricks, concrete, blocks, plaster, lumber, reinforcing rods, roofing material, and other similar objects

*Maximum size of object:
Largest dimension not to exceed tank diameter, less 14 inches

**Subject to local regulations

OPERATING CHARACTERISTICS - Mechanical Conveyors

Characteristics of the mechanical conveyor components required in this plant are described in the following (item numbers refer to keyed numbers on Figure VI-3):

Load-in Conveyor, 1 required (item 2B in bottom of storage bin), apron type, 40'L x 8'W, 50 TPH capacity, speed variable 2 to 10 FPM with jog capability, 2 HP motor, intermittent duty, with speed changes and jogging, maximum load 200 lbs. per sq. ft.

Load-out Conveyor, 1 required (item 2C in bottom of storage bin), type apron, 24'L x 8'W, 50 TPH capacity, speed variable 2 to 10 FPM with jog and reverse capability, 2 HP motor, maximum load 200 lbs. per sq. ft., duty requires frequent stops and starts, speed changes, jogging and reversing.

Vibrating Conveyor, 1 required (item 3), 12'L x 4'W x 18"H, 10 TPH capacity, 1" stroke @ 200 FPM, intermittent duty with frequent starts and stops.

Tripper Belt Conveyor, 1 required (item 4), 30" belt troughed at 35° for 6" each side, 70' o.a.l., 45' horiz. and 25' @ 20° incl., max. load 16 #PSF, avg. load 4 #PSF, speed 100 FPM, 5 HP motor, 10 TPH capacity, intermittent duty with frequent starts and stops.

Tripper, 1 required (item 4a), movable, powered with cable and reel, size and cap. to match 4 above, remote control of location and discharge, bypass back onto belt, intermittent duty with frequent position changes.

Pulper Feed Conveyor, 2 required (item 5), 24" belt troughed @ 35° for 6" each side, 20' c. to c., 20° max. incline, speed variable 10 to 20 FPM, 2 TPH capacity, continuous duty.

Bypass Conveyor, 1 required (item 6), 36" belt troughed @ 35° for 6" each side, 57' c. to c., 20° incline, 135 FPM, 16 TPH capacity, continuous duty.

Grit and Junk Conveyor, 1 required (item 11), type either belt or screw, size 12" belt or 9" screw, 28' c. to c., horiz., speed 150 FPM or 15 RPM, 2 TPH capacity, continuous duty.

Bucket Elevator, 1 required (item 12), lift 24', incline 70°, 2 TPH capacity, continuous duty.

OPERATING CHARACTERISTICS - Wet Air Oxidation System

The wet air oxidation system shall include equipment, piping, valves, motor control center, instrumentation and insulation. Principal components of the system shall include two air compressors (400 psig), equipped with 100 HP motors, one hydraulic pressure pump (25 GPM) equipped with a 15 HP motor, one high pressure hydraulically operated sludge pump, one sludge feed pump equipped with a 5 HP motor, one solvent pump (20 GPM) equipped with a 10 HP motor, one solvent tank constructed of 304 stainless steel or fiber glass, one gas fired boiler (400 psig), one heat exchanger with concentric piping of 304 stainless steel tested at 1200 psig, one reactor for operation at 400 psig and 400°F. tested at 1200 psig, one separator designed for operation at 400 psig and 400°F. tested at 1200 psig, one gas fired catalytic vapor oxidation unit, one pulped sludge storage tank (24,000 gallon capacity), and one oxidized sludge thickening tank (24,000 gallon capacity).

The system shall be so designed as to produce a sterile and dewaterable oxidized end product. Flameless combustion of the pulped sludge shall take place in an aqueous state. The oxidized solids shall be dewaterable, without the addition of chemical coagulants, to a moist solid which is non-putrescible, biologically stable and free of obnoxious odors.

Based on the calculated 13,000 pounds of pulpable wastes (dry weight) generated daily at the LAC-USC Medical Center, this low pressure oxidation system shall have the capability of handling slurries at a digestion rate of 1000 pounds per hour (dry solid weight) or 24,000 pounds daily under continuous operation. The capabilities of the system shall permit a maximum of 50% reduction of insoluble organic matter and 90% solubilization and oxidation of polyethylene plastics.

OPERATING CHARACTERISTICS - Experimental Sewage Treatment Plant

The purpose of this plant will be to determine the effect on conventional sewage treatment plants from the addition of various quantities of pulped refuse to the sewage, to determine what modifications may be required in sewage treatment plant design and operation to treat mixtures of pulped refuse and sewage satisfactorily, and to evaluate the effectiveness of processing pulped refuse at a sewage treatment plant.

The plant will treat a proportioned mix of domestic sewage taken from a sewer in the vicinity and controlled quantities of pulped refuse taken from the storage tanks at the waste processing plant. The plant will provide a maximum of flexibility within and between its various elements to facilitate the testing of the various processes and will have a capacity of 30 gpm or 43,000 g.p.d. The design will be based on the use of steel tanks which can be removed at the end of the program.

Design Criteria:

1. Average Flow 43,000 g.p.d.

2. Population Equivalent 430 persons

3. Assume solid loading at 1.2#/cap./day or 500#/day
   Equivalent to 1000 g.p.d. of 6% pulp

4. Mixing Chamber — Detention time 15 minutes = 465 gal.
   Say 4'Dia. and 5' S.W.D. with variable speed mixer

5. Primary Clarifier — Detention 2 1/2 hrs. = 4500 gal.
   Say 12' Dia. and 6' S.W.D. with sludge scrapper, central feed and peripheral discharge
   No skimmer required

6. Aeration — Detention time 24 hrs. 43,000 gal.
   Say 2-20' Dia. and 9' S.W.D. with variable speed bridge mounted mechanical aerators

7.	Secondary Clarifier	Detention time 2 hrs. with 25% return 4500 gal. Say 12' Dia. and 6' S.W.D. with sludge scrapper, center feed and peripheral discharge
8.	Sludge Processing	Aerobic Digestor for 1/2 capacity at 15 cu.ft./cap = 6450 cu.ft. Say 20' Dia. and 20' S.W.D. with floating aerator
		Anaerobic Digestor for 1/2 capacity at 15 cu.ft./cap = 6450 cu.ft. Say 20' Dia. and 20' S.W.D. with floating cover
		Wet air Oxidation provide sludge thickening tank Say 6' Diameter and 7' S.W.D. 1000 gal. of thickened sludge to be processed at 25 gpm = 40 min. operation daily
		Dewatering Use Vacuum Filter at pulping installation

ESTIMATED ANNUAL OPERATING COSTS

Annual direct operating costs of the total project, excluding capital costs, are estimated at $202,000. The breakdown of these costs to the basic elements of the project, i.e. the waste system, experimental sewage treatment plant and laboratory testing, are estimated as shown in Table VI-2.

TABLE VI-2 ANNUAL OPERATING COSTS OF PROJECT FACILITIES

	Solid Waste System	Sewage Tr. Plant	Laboratory	Total
*Payroll	$ 61,000	$32,000	$27,000	$120,000
Materials, Equip. & Supplies	5,000	3,000	12,000	20,000
Maintenance	4,000	4,000	2,000	10,000
Power & Fuels	50,000	2,000	-	52,000
TOTAL	$120,000	$41,000	$41,000	$202,000

*Includes taxes, insurance and social benefits

The analysis of economic benefits of the project must consider only those costs associated with the operation of the waste system and not those involved with research activities. Implementation of the proposed waste system, although largely limited in effect to those costs and functions in the existing inter-unit, inter-building and off-site systems, also will have some effect on preparation and handling of certain disposable wastes in the unit system (patient care and service areas). Based on these system modifications, Table VI-3 was prepared showing the changes in daily payroll costs that may be expected. Comparisons of labor costs by categories of wastes, as well as costs of operation by system components or sub-systems, can be made with Table II-13 (Volume II, Chapter II), the estimated daily labor costs of the existing

TABLE VI-3 ESTIMATED DAILY LABOR COSTS OF THE MODIFIED WASTE SYSTEM - LAC-USC MEDICAL CENTER

	Unit System					Inter-Unit System					Inter-Building System					Off-Site System					
Types of Waste	Type Employee	Pay Rate	Hr./Day	Emp. Total	Unit System Total	Type Employee	Pay Rate	Hr./Day	Emp. Total	Unit System Total	Type Employee	Pay Rate	Hr./Day	Emp. Total	Unit System Total	Type Employee	Pay Rate	Hr./Day	Emp. Total	Unit System Total	TOTAL
Sharps, Needles, Etc.	Nurse	$5.72	10.0	$ 57.20	$ 57.20						Equip. Op.II	$4.94	0.3	$ 1.48	$ 2.01						$ 59.21
											Equip.Op.I	5.28	0.1	0.53							
Pathological and Surgical	Lab.Tech.	4.12	1.0	4.12	5.98	Custodian	$3.71	0.5	$ 1.86	$ 1.86	Lab.Tech.	4.12	3.0	12.36	12.36						20.20
	Custodian	3.71	0.5	1.86																	
Soiled Linen	Nurse	5.72	94.0	537.68	851.64						Equip. Op.II	4.94	16.8	82.99	82.99						934.63
	Attendant	3.34	94.0	313.96																	
Rubbish	Custodian	3.71	525.0	1947.75	1947.75						Equip. Op.II	4.94	6.0	29.64	64.49						2012.24
											Equip.Op.I	5.28	6.6	34.85							
Reusable Patient Items	Nurse	5.72	15.0	91.52	311.96																311.96
	Attendant	3.34	66.0	220.44																	
Non-Combustible	Custodian	3.71	10.0	37.10	37.10						Equip. Op.II	4.94	0.3	1.48	4.65	Truck Dr.	$4.74	1.0	$4.74	$4.74	46.49
											Equip.Op.I	5.28	0.6	3.17							
Garbage (Non-Grindable)	Attendant	3.34	3.0	10.02	10.02						Equip. Op.II	4.94	0.6	2.96	6.66						16.68
											Equip.Op.I	5.28	0.7	3.70							
Food Service Items	Nurse	5.72	142.0	812.24	1286.52	Elev.Op.	3.71	7.25	26.90	26.90	Tram Dr.	4.03	3.5	14.11	89.78						1403.20
	Attendant	3.34	142.0	474.28							Fd.Srv.Wk	3.42	18.0	61.56							
											Inst.Lab.	4.03	3.5	14.11							
Radiological	Lab.Tech.	4.12	0.5	2.06	2.80	Elev.Op.	3.71	0.3	1.11	2.22	Custodian	3.71	1.0	3.71							8.73
	Custodian	3.71	0.2	0.74		Custodian	3.71	0.3	1.11												
Ash & Residue	Inst. Lab.	4.03	0.1	0.40	0.40						Equip. Op.II	4.94	0.1	0.49	0.49						0.89
Animal Carcasses	Lab.Tech.	4.12	0.75	3.09	3.09						Lab.Tech.	4.12	0.5	2.06	2.06						5.15
Food Waste (Grindable)	Fd.Srv.Wk	3.42	27.0	92.34	92.34																92.34
					$4606.80					$30.98					$269.20					$4.74	$4911.72

solid waste system.

It is anticipated that the effect of the proposed system will reduce total daily labor costs from the present level of $6,232.46 to $4,911.72, or a daily savings of $1,320.74. The largest increment of this savings, an amount of $981.60, is estimated to accrue from the combined functions of inter-unit, inter-building and off-site systems. Additional labor savings of $304.92 are estimated to occur in the unit system as a result of changes of methods, practices and the elimination of separate collection systems, such as sharps and needles, made possible by the system modifications.

Increases in certain operational costs, such as materials, supplies, maintenance, power and fuels are attributed to the new system. Collectively, these added costs are estimated at $60,000 annually, or $164.38 per day. With these offsetting costs considered, savings in direct operating costs are reduced to $1,156.36, or a net reduction in operating costs of about 18.6% in the total system is anticipated.

ESTIMATED CONSTRUCTION COSTS

Development of the total project previously described, including the pneumatic conveyor system, waste processing plant and the experimental sewage treatment plant, and based upon preliminary plans, is estimated to cost $3,180,410, as shown in Table VI-4, including contingencies and engineering, but excluding land.

Excluding the costs of the experimental sewage treatment plant and related contingencies and fees, the net cost of the permanent solid waste system installation as proposed for the Medical Center is about $3,000,000.

TABLE VI-4 ESTIMATED CONSTRUCTION COSTS

A. Pneumatic Conveyor System	$	$
1. Pipe System, including inlets and controls	1,275,457	
2. Evacuators, Filters, Hoppers, etc.	176,000	
3. Electric Power and Controls	142,000	1,593,457
B. Sewage Pump Station		
1. Structure	25,000	
2. Pumps and Controls	21,000	
3. Piping	3,000	
4. Electrical	2,000	51,000
C. Outside Piping		
1. Diversion Chamber	2,000	
2. 800 lf.-12" V.C. Sewer @ $12	9,600	
3. 800 lf.-8" C.I. Force Main @ $8	6,400	18,000
D. Processing Plant		
1. Building 175,000 cf. @ $1	175,000	
2. Tank Screening 6,000 sf. @ $6	36,000	211,000
E. Fabricated Plate		
1. Inlet Hopper	2,400	
2. Storage Bin	6,250	
3. Bypass Hopper	750	
4. Pulper Storage	4,270	
5. Loading Hopper	4,700	
6. Storage Tanks	17,400	
7. Conveyor Supports	2,000	37,770
F. Materials Handling Systems		
1. Load in Conveyor 40'L x 8'W 50 T.P.H.	11,000	
2. Load out Conveyor 24'L x 8'W 50 T.P.H.	8,000	
3. Leveling Conveyor Vibratory 12'L x 4'W 10 T.P.H.	4,500	
4. Tripper Belt Conveyor 70'L x 30" W 10 T.P.H.	9,000	
5. Tripper	5,500	
6. 2 Pulper Feed Conveyors 20'L x 24"W 2 T.P.H.	6,000	

F.	Materials Handling Systems (continued)		
	7. Bypass Conveyor troughed belt 57'L x 36"W	$ 1,500	$
	8. Grit & Junk Conveyor screw type 9" x 28'	4,000	
	9. Grit & Junk Elevator bucket type	3,000	
	10. Installation (40% x $52,500)	21,000	73,500
G.	Pulping Equipment		
	1. 2-60" diam. Pulpers		
	2. 2-500 gpm Feed Pumps	102,500	
	3. 2-6" Degritters		
	4. 2-9" Screw type Thickeners		
	5. Installation (40% x $102,500)	41,000	143,500
H.	Wet Oxidation Plant		
	1. 1 H.P. Air Compressor		
	2. 1 H.P. Feed Pump		
	3. 1 Bailer Assembly 800 psi		
	4. 1 Heat Exchanger 800 psi		
	5. 1 Reactor 800 psi		
	6. 1 Separator 800 psi		
	7. 1 Catalytic Oxidation Unit		
	8. 1 Solvent Tank & Pump		
	9. 1 Vacuum Filter		
	10. 1 Vacuum Pump		
	11. 1 Conveyor		
	12. Installation		375,000
I.	Electrical		71,500
J.	Hopper Weighing Scale		7,500
	Total Estimated Cost of Solid Waste System		$2,582,227
K.	Experimental Sewage Treatment Plant		125,000
	Total Estimated Construction Costs		$2,707,227
L.	Contingencies 10%		270,723
	Total Construction Budget		$2,977,950
M.	Engineering Fee		202,460
	Total Estimated Cost		$3,180,410

Note: Component Costs Are More Refined Than Those Shown in Table III-2

BENEFITS OF THE SYSTEM

It is estimated that the net investment required will produce an annual advantage or savings of $498,350 before depreciation, or return the initial investment in about six years. Assuming a straight line depreciation on the installation, with a 10-year life allowed on the pulping station equipment (value about $400,000) and a 25-year life allowed on the structures, pneumatic system, wet oxidation plant, etc. (value about $2,600,000), annual depreciation costs can be calculated at about $144,000. A net annual surplus of $354,350 available for other improvements or patient care functions, and representing a return of 12.1% on the invested capital, is anticipated after depreciation.

Table VI-5 summarizes the tangible economic benefits to be derived from the implementation of the project, incorporating those direct operating benefits as noted, together with certain indirect benefits that accrue due to elimination of certain parts of the existing system.

Certain intangible benefits with monetary value will also accrue as a result of operating the improved solid waste system. Improvement in sanitation, safety, security and esthetics may likely have an effect on the frequency of personal injury, accidents, illness of personnel, as well as patients throughout the plant and perhaps the greatest effect on those being associated with the direct handling of the waste materials. Similarly, limiting the exposure of wastes in transport and off-site disposal would likely have a beneficial effect to the community at large. Improvement in systems operation and these related environmental conditions should also tend to reduce the general cost of building maintenance and losses due to fire or other casualty. This improved system using an isolated and specialized transport method will reduce congestion in building corridors, allowing more efficient performance of other service functions. Economic analysis of annual dollar savings that may accrue from these benefits would require a multitude of record statistics of plant operation that are not available and adequate bases of fact are not at hand to permit an intelligent detailed estimate. However, it is conceivable that collectively the intangible benefits could equal, if not exceed, the estimated value of tangible benefits.

The improvement in environmental conditions which result from the modified system are more readily identifiable than the economics of intangible benefits. Table VI-6 shows the numerical rating of the improved system by categories of wastes, sub-systems

TABLE VI-5 TANGIBLE ECONOMIC BENEFITS

Investment Requirement:	
Installed Cost of Project	$3,000,000
Less Salvage Allowance of Existing Waste System Equipment (1)	- 28,000
Less Avoided Cost of Capital Improvements to Existing System (2)	- 50,000
NET INVESTMENT REQUIRED	$2,922,000
Direct Operating Benefits (3):	
Operating Labor (4)	$ 541,650
Less Increase in other Operating Costs:	
Maintenance	- 4,000
Materials and Supplies	- 5,000
Power and Fuels	- 50,000
NET ANNUAL OPERATING ADVANTAGE	$ 482,250
Indirect Benefits (Recurring Annual Savings):	
Annual Decline in Equipment Salvage Value of Existing System (5)	$ 2,800
Annual Depreciation on Capital Improvements Avoided (6)	5,000
Annual Value of Building Areas Released for Other Use (7)	8,300
TOTAL ANNUAL ADVANTAGE OR SAVINGS	$ 498,350
Less Annual Depreciation Expense	$ 144,000
NET ANNUAL RETURN ON INVESTMENT	$ 354,350
% Return on Investment	12.1%

(1) Approximately 1/3 the estimated cost of present inter-building and off-site equipment
(2) Allowance for alternate minimum annual improvements to solid waste system
(3) Savings in annual operating costs
(4) Net annual savings over present labor costs
(5) 10% of present allowed value or (1) above
(6) Allow 10-year life on annual improvements (2) above
(7) Allowance of 1/2 of in-building storage areas or 4,150 SF @ $2.00/SF/Yr.

TABLE VI-6 NUMERICAL RATING OF PROPOSED SOLID WASTE SYSTEM - LAC-USC MEDICAL CENTER

Type of Waste		Unit System								Inter-Unit System						Inter-Building System								Off-Site System							
		Initial Deposit (Receiver)		Initial Transfer		Initial Storage, Processing, Disposal				Vertical Transfer		Intermediate Storage, Processing, Disposal				Internal Transfer		Central Storage		Central Processing or Disposal				External Transfer		Final Processing and/or Disposal					
		Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value Total	Max. Value Total	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value Total	Max. Value Total	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value Total	Max. Value Total	Def. Value	Max. Value	Def. Value	Max. Value	Def. Value Total	Max. Value Total	Def. Value Total	Max. Value Total
Sharps, Needles, Etc.	Sanitation	0	40	0	50		20	0	110	12	50		20	12	70	0	50	3	10	5	20	8	80	0	20	0	80	0	100	20	360
	Safety	10	40	0	50		10	10	100	0	45		10	0	55	0	45	1	5	2	10	3	60	0	10	0	75	0	85	13	300
	Security	0	30	0	5		25	0	60	0	5		25	0	30	0	5	0	25	0	10	0	40	0	10	0	60	0	70	0	200
	Esthetics	0	5	0	5		5	0	15	0	5		5	0	10	0	5	2	5	1	5	3	15	0	5	0	20	0	25	3	65
Surgical, Pathological & Animals	Sanitation	10	20	15	35	25	35	50	90	15	20	35	35	50	55	5	10	10	10	40	40	55	60		20		75		95	155	300
	Safety	2	5	5	10	2	5	9	20	2	5	7	10	9	15	12	15	10	10	5	5	27	30		5		5		10	45	75
	Security	0	5	0	5	35	35	35	45	0	5	25	35	25	40	2	5	20	20	5	5	27	30		10		75		85	87	200
	Esthetics	5	10	2	5	11	15	18	30	2	5	11	15	13	20	2	5	15	15	10	10	27	30		5		15		20	58	100
Soiled Linen	Sanitation	30	40	35	50		30	65	120	20	80		50	20	130	0	30	7	30	20	40	27	100		10		40		50	112	400
	Safety	2	5	2	5		5	4	15	0	5		5	0	10	0	10	1	5	7	15	8	30		5		15		20	12	75
	Security	2	5	2	5		5	4	15	0	5		15	0	20	0	15	0	20	2	5	2	40		15		5		20	6	95
	Esthetics	15	20	10	15		10	25	45	0	10		10	0	20	0	5	2	5	2	5	4	15		5		15		20	29	100
Rubbish	Sanitation	2	5	5	10		10	7	25	5	20		15	5	35	0	10	2	10	4	15	6	35	0	10	0	55	0	65	18	160
	Safety	7	15	10	20		25	17	60	0	20		45	0	65	0	15	6	25	6	25	12	65	0	10	0	25	0	35	29	225
	Security	2	5	2	5		20	4	30	0	5		15	0	20	0	5	0	15	0	10	0	30	0	15	0	30	0	45	4	125
	Esthetics	15	15	7	15		10	22	40	0	10		10	0	20	0	5	1	5	1	5	2	15	0	10	0	15	0	25	24	100
Reusable Patient Items	Sanitation		15	10	20	5	25	15	60		15		15		30		20		10		15		45		10		15		25	15	180
	Safety		15	10	20	0	5	10	40		15		5		20		15		5		15		35		10		15		25	10	120
	Security		15	0	5	7	15	7	35		5		15		20		10		15		15		40		10		15		25	7	120
	Esthetics		5	2	5	2	5	4	15		5		5		10		5		5		5		15		5		5		10	4	50
Non-Combustible	Sanitation	2	5	5	10		10	7	25	4	15		5	4	20	0	5	1	5	1	5	2	15	2	5	30	55	32	65	45	120
	Safety	10	20	5	15		20	15	55	0	15		20	0	35	0	10	2	10	2	10	4	30	0	5	13	25	13	30	32	150
	Security	5	10	0	5		15	5	30	0	5		10	0	15	0	5	0	10	0	5	0	20	0	5	15	15	15	20	20	85
	Esthetics	5	10	2	5		5	7	20	0	5		5	0	10	0	5	1	5	1	5	2	15	2	5	2	5	4	10	13	55
Garbage (Non-Grindable)	Sanitation	2	5	2	5		15	4	25	1	5		15	1	20	0	5	1	5	4	15	5	25	0	10	0	15	0	25	10	95
	Safety	2	5	2	5		5	4	15	0	5		5	0	10	0	5	1	5	1	5	2	15	0	5	0	10	0	15	6	55
	Security	0	5	0	5		5	0	15	0	5		5	0	10	0	5	0	5	0	5	0	15	0	5	0	5	0	10	0	50
	Esthetics	4	15	1	5		10	5	30	0	5		10	0	15	0	5	2	10	1	5	3	20	0	15	0	20	0	35	8	100
Food Service Items	Sanitation	2	5	2	5	7	10	11	20	2	5	7	10	9	15	2	5	2	5	3	15	7	25		5		15		20	27	80
	Safety	5	10	5	10	7	10	17	30	2	5	7	10	9	15	2	5	2	5	0	10	4	20		5		10		15	30	80
	Security	0	5	1	5	5	5	6	15	2	5	5	5	7	10	2	5	5	5	2	5	9	15		5		5		10	22	50
	Esthetics	2	5	2	5	3	5	7	15	2	5	2	5	4	10	2	5	5	5	2	5	9	15		5		5		10	20	30
Total	Sanitation	48	135	74	185	37	155	159	475	59	210	42	165	101	375	7	135	26	85	77	165	110	385	2	90	30	350	32	440	402	1675
	Safety	38	115	39	135	9	85	86	335	4	115	14	110	18	225	14	120	23	70	23	95	60	285	0	55	13	180	13	235	177	1080
	Security	9	80	5	40	47	129	61	245	2	40	30	125	32	165	4	55	25	115	9	60	38	230	0	75	15	210	15	285	146	925
	Esthetics	46	85	26	60	16	65	88	210	4	50	13	65	17	115	4	40	28	56	18	45	50	140	2	55	2	100	4	155	159	620
TOTAL		141	415	144	420	109	430	394	1265	69	415	99	465	168	880	29	350	102	325	127	365	258	1040	4	275	60	840	64	1115	884	4300

and sub-system functions within the total system. Comparison of this rating with Table II-18 (page II-53, Volume II), the numerical rating of the existing solid waste system operation, shows the detail of the decrease in deficiencies accomplished by the improved system. The total effect of these improvements can be summarized as shown in Table VI-7, showing percentage deficiencies by sub-system functions in the existing system and the improved system. Graphically, these effects are also illustrated in Figure VI-6.

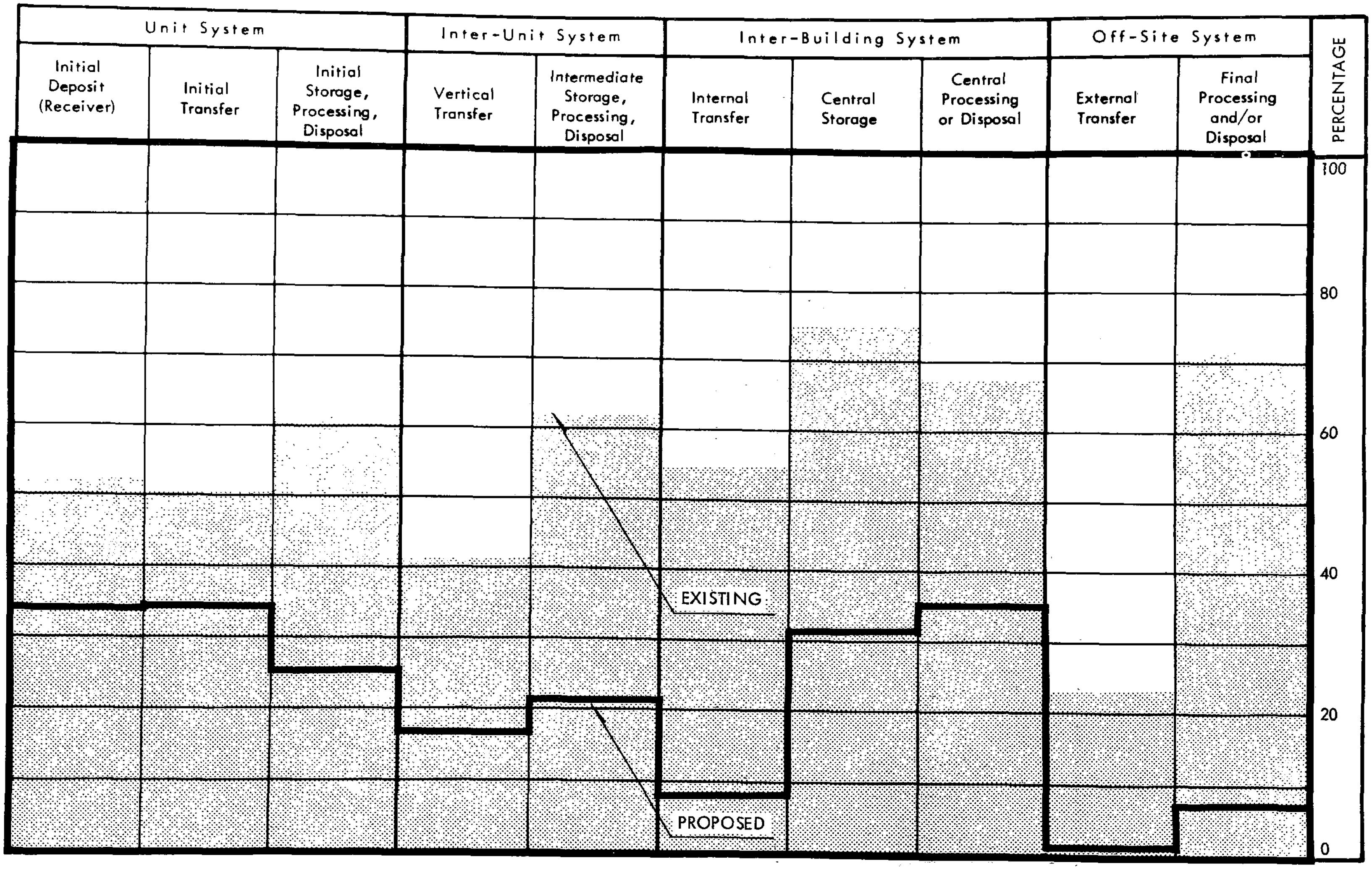
It is estimated that a decrease of 64.7% in present deficiencies of system operation can be accomplished with the proposed improvements. The remaining deficiencies are largely associated with those reusables (patient and food service items) not entering the modified system, as well as the initial handling of nearly all items in the unit system prior to entering the modified portions of the system. In the case of the latter, further reduction of deficiencies in operation are likely to come about only through enforcement of policies and closer supervision and not through mechanization in the foreseeable future.

In summary, marked improvement in environmental conditions (both in-plant and off-site) can be accomplished through implementation of the proposed modifications. Those tangible economic benefits as identified indicate these improvements can be made comfortably within the present level of costs; in fact, will likely provide a substantial operating surplus. Intangible benefits, though not of identifiable value, will in all likelihood provide substantial economic bonus in the plant operation.

TABLE VI-7 PERCENTAGE DEFICIENCIES OF SUB-SYSTEM FUNCTIONS

Sub-System and Function	LAC-USC MEDICAL CENTER	
	Existing System	Improved System
UNIT SYSTEM:		
Initial Deposit	52.3	34.0
Initial Transfer	50.5	34.3
Initial Storage	62.1	25.3
Weighted Average	55.0	31.1
INTER-UNIT SYSTEM:		
Vertical Transfer	41.2	16.6
Intermediate Storage	62.2	21.3
Weighted Average	52.0	19.1
INTER-BUILDING SYSTEM:		
Internal Transfer	54.9	8.3
Central Storage	74.8	31.4
Central Processing or Disposal	67.4	34.8
Weighted Average	68.0	24.8
OFF-SITE SYSTEM:		
External Transfer	23.3	1.5
Final Processing or Disposal	71.8	7.1
Weighted Average	60.0	5.7
TOTAL SYSTEM	58.0	20.6
% DECREASE OF DEFICIENCIES	-	64.7

FIGURE VI-6 COMPARISON OF PERCENTAGE DEFICIENCIES OF SUB-SYSTEM FUNCTIONS - LAC-USC MEDICAL CENTER



RECOMMENDATIONS FOR IMPLEMENTATION

Based upon the foregoing study and evaluation of the existing system operation, considered alternative methods of improvement, the concept of the proposed modifications and development of this concept through preliminary planning stages, cost estimates and the analysis of tangible benefits, this project is recommended as a solution to the more critical problems of the current solid waste system at LAC-USC Medical Center. It is a solution with qualifying economic and environmental benefits. Through the waste processing and disposal methods employed, minimal emissions are contributed to the already critical air pollution conditions of the Los Angeles Basin. A homogeneous residue is also produced by processing for disposal at landfills or discharge to sewers.

In summation, the proposed project meets local needs while also providing a laboratory for study and experimentation on the pneumatic handling system in combination with a number of optional disposal methods and processes that may have potential application in various size hospital plants throughout the country.

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