David L Ozeko

RESEARCH STUDY
ON
REFUSE COLLECTION
FOR
WELFARE ISLAND

FOR
NEW YORK STATE
URBAN DEVELOPMENT CORPORATION

SEPTEMBER, 1970

Gibbs & Hill, Inc.
ENGINEERS, DESIGNERS, CONSTRUCTORS
NEW YORK

Gibbs & Hill, Inc.
ENGINEERS DESIGNERS CONSTRUCTORS

September 18, 1970

Mr. Charles I. Shannon
New York State Welfare Island Development Corporation
1345 Avenue of the Americas
New York, N. Y. 10019

Dear Chuck:

WELFARE ISLAND
G&H PROJECT NO. 2133-A
PRELIMINARY STUDY REPORT OF REFUSE COLLECTION SYSTEMS

We are pleased to submit, herewith, twenty (20) copies of our preliminary study report, entitled "Research Study on Refuse Collection Systems for Welfare Island", for your review and comments. It should be read in conjunction with our preliminary report on "Research Study on Refuse Disposal Systems for Welfare Island", submitted to you on August 7, 1970.

In addition, we would like to point out the following:

1) As recommended in our report if the pneumatic refuse collection system would be adopted for implementation on the Island, it would be necessary to negotiate with Aerojet General Corporation for a further study in order to finalize the system configuration and detailed cost estimate. This study to be undertaken by the Aerojet will be performed under our immediate supervision in order to assure that the recommended system would meet all the functional requirements necessary for refuse collection on the island.

2) We recommend that the possibility of obtaining some kind of Federal demonstration grant for the implementation of the pneumatic refuse collection system should be further investigated.

3) With the implementation of the pneumatic refuse collection system, it appears to us that some kind of a "compensation" for your capital investment should be negotiated with the City as the completed system will result in a considerable saving of the operating cost on the part of the City when compared with a conventional pick-up method. The City has the responsibility to collect refuse from apartment buildings owned by "tax-payers".

4) Your early decisions on the above are mandatory in order to assure a successful completion of the Welfare Island Development Project.

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5) The City has expressed their interest to connect the Island pneumatic refuse collection system directly from the Island to the 73rd Street Incinerator in Manhattan. We have serious doubts in its technical feasibility; however, subject to your approval, we would cooperate with the City on any further study necessary in this aspect.

6) During the final design stage, we shall further investigate the problem of peak capacity control for the refuse collection, if necessary by means of a digital computer, in order to achieve some capital cost saving, if possible.

We are looking forward to discussing this preliminary report in detail with you and your staff.

Very truly yours,

GIBBS & HILL, Inc.

Chok-hung Lee
Project Manager

CHL:lv

TABLE 9
(Sheet 1 of 2)

PRELIMINARY COST ESTIMATE FOR COMMUNITY CURBSIDE COLLECTION AND LARGE CONTAINERS FOR HOSPITALS

	By WIDC	Developers and Businesses	NYC Bd. of Ed. (Schools)	NYC Dept. of San.	Item Total
1. COMMUNITY CURBSIDE PICKUP					
a. Capital Costs[1]					
1) Source buildings					$1,904,000
a) Compactor rooms; residential and commercial, structure	-	$ 954,000	-	-	
b) Bagging compactors, compactors for commercial use, hand carts equipment	-	950,000	-	-	
2) City collection trucks	-	-	-	$218,000	218,000
Curbside Total Capital	-	$1,904,000	-	$218,000	$2,122,000
b. Annual Costs					
1) Source buildings					
a) Porter labor, bagging operations, and placing bags at curb, handling assembled refuse for residential, community and commercial bldgs	$ 7,700	$ 373,500	$ 8,000[2]	-	
b) Bagging compactors power	-	5,500	-	-	
c) Bags, supplies and maintenance of bagging compactors	-	90,000	-	-	
Subtotal	$ 7,700	$ 468,000	$ 8,000	-	$ 483,700
2) Transfer off-Island					
a) Vehicle operating labor for residential community and school refuse transfer	-	-	-	$670,500	
b) Vehicle operation and maintenance	-	-	-	89,400	
c) Private carters for commercial refuse transfer (includes collection fees, and disposal fee to New York City)	-	$ 131,000	-	-	
Subtotal	-	$ 131,000	-	$759,900	890,900
3) Amortization and interest					
a) 40-year structures	-	$ 72,500	-	-	
b) 20-year equipment	-	91,200	-	-	
c) 5-year vehicles	-	-	-	$ 53,200	
Subtotal	-	$ 163,700	-	$ 53,200	215,900
Curbside Total Annual	$ 7,700	$ 763,700	$ 8,000	$813,100	$ 1,592,500

(See sheet 2 for footnotes)

TABLE 9
(Sheet 2 of 2)

PRELIMINARY COST ESTIMATE FOR COMMUNITY CURBSIDE COLLECTION AND LARGE CONTAINERS FOR HOSPITALS

	NYC Hosp. Corp. (Hospitals)	NYC Dept. of Sanitation	Item Total
2. HOSPITAL CONTAINER SYSTEM			
a. Capital Costs[1]			
1) Compactor-container loading station; civil and structural[1]	$ 348,000 (S)	-	
2) Compactor stations equipment[1]	232,000 (E)	-	
3) Truck chassis equipment[3]	-	$ 87,000 (E)	
Structures (S)	348,000	-	$ 348,000
Equipment (E)	232,000	87,000	319,000
Hospital Total Capital			667,000
Curbside Total Capital (sheet 1)	$ 580,000	$ 87,000	2,122,000
		Grand Total Capital Cost	$ 2,789,000
b. Annual Costs			
1) Operating labor and maintenance			
a) Internal collection labor	$ 302,400	-	
b) Compactor power	4,500	-	
c) Equipment maintenance	4,000	-	
d) Vehicle operating labor	-	$ 176,400	
e) Vehicle operation & maintenance	-	44,100	
Subtotal	$ 310,900	$ 220,500	$ 531,400
2) Amortization and interest			
a) Structures, 40 years	$ 26,400	-	
b) Equipment, 20 years	22,300	-	
c) Vehicles, 5 years	-	$ 21,200	
Subtotal	$ 48,700	$ 21,200	69,900
Hospital Total Annual			$ 601,300
Curbside Total Annual	$ 359,600	$ 241,700	1,592,500
		Grand Total Annual Cost	$ 2,193,800

[1] These items include 15% over base for engineering and contingency, and 30% over base for escalation to 1973.

[2] School source building labor costs are less than for vacuum system (Table 8), because more janitor time would be used in charging vacuum collection chute.

[3] City trucks for hospitals are higher than on Table 8 which assumes one truck for transfer station and one truck for hospitals, and one spare used for both. Curbside community collection uses different trucks, therefore hospital service requires one complete spare.

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CONTENTS

RESEARCH STUDY

ON

REFUSE COLLECTION SYSTEMS

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1. STUDY OBJECTIVES

This study was conducted to evaluate a pneumatic system of refuse collection and to compare it with other collection methods.

2. SCOPE

Amounts and classification of solid wastes to be collected on the Island have been estimated.

The AVAC pneumatic collection system, presently operating in Sweden, has been evaluated as to availability and technical feasibility. Other collection methods have been studied including underground container train and conveyor belt systems, and costs have been compared. The cost of usual curbside refuse pickup has been estimated for comparison.

3. SUMMARY AND RECOMMENDATIONS

3.1 Quantity

The Island project will generate waste in quantities estimated to be as follows:

	Lbs. per Day	
	1970	1980
Residential	50,200	75,600
Commercial	14,000	23,000
School & Community Facilities	3,700	5,600
Hospitals	28,000	69,000
Sub-Total	95,000	173,200
Bulk	10,000	10,000

3.2 Possible Alternatives

Several alternative systems have been considered for the underground collection of refuse.

a. AVAC underground pneumatic system.

b. Container train system operating in tunnels.

c. Conveyor belt system operating in tunnels.

Possible systems requiring collection at street level include:

d. Large container pickup at each building

e. Conventional curbside pickup of compacted refuse in bags or small containers.

3.3 New York City Collection

The New York City Department of Sanitation will collect residential refuse from all residential taxpayers within the City. Local Law 14, 1968 requires compaction of refuse from highrise multiple dwellings. In east Manhattan, pickups are made twice a week.

Commercial or industrial solid wastes are not collected by the City. Ordinarily. these must be picked up and hauled away by private carters who may dispose of combustible materials at City incinerators for a nominal fee, presently about $2.50 per ton.

The fullest extent of City collection service which might be provided on the Island under the terms of the UDC lease has yet to be determined.

3.4 Costs

a. The estimated first costs for collection systems are:

	Towns Only	Add for Hospitals	Total All Island
AVAC pneumatic system - direct	$ 6,895,000	$1,495,000	$8,390,000
AVAC pneumatic system - branched	7,760,000	1,500,000	9,260,000
Container Train	10,410,000	2,340,000	12,750,000
Belt Conveyor	13,750,000	2,450,000	16,200,000
Conventional Pickup	1,640,000	340,000	1,980,000

b. Estimated annual costs are:

	Towns Only	Add for Hospitals	Total All Island
AVAC pneumatic system - direct	$ 697,000	$182,000	$ 879,000
AVAC pneumatic system - branched	770,000	182,000	952,000
Container Train	1,055,000	346,000	1,401,000
Belt Conveyor	1,420,000	399,000	1,819,000
Conventional pickup	434,000	178,000	612,000

Cost data for the AVAC pneumatic system have been developed by G&H as order of magnitude estimates based upon an Aerojet-General preliminary telephoned estimate and their additive unit prices for a few specific pieces of hardware.

Aerojet-General's preliminary estimate for the all-Island collection was based upon the Johnson and Burgee arrangement. This has since been substantially modified, and although the internal arrangement and building cores are not yet defined, it appears that an increased number of residential services may be required.

Aerojet-General has declined requests for additional preliminary cost estimates which would normally be provided by equipment suppliers. Rather, they have proposed to develop further cost data for a fee of $20,000 to $25,000 as outlined in their Phase 1. proposal described in Section 7.4.

3.5 Recommendations

The AVAC pneumatic system has too much potential to be dismissed. However, since there is no operating installation in the United States, it should not be accepted without further in-depth study of operating and maintenance history.

This further investigation is required to confirm that AVAC is a mechanically reliable system, appropriate for U.S. municipal refuse service, and that the costs for its installation and maintenance will not be excessive.

If shown to be feasible, it is without question the method most appropriate to minimize noise, litter, odors. traffic congestion and high labor costs associated with conventional urban refuse collection.

The benefits of pneumatic collection would all contribute to the overall objectives:

- Cleanliness
- Concealment
- Expected minimization of labor costs
- No traffic interference
- Reduced pedestrian accident hazard
- Utilization of the newest technology

a. We recommend a series of meetings among UDC, G&H, and City Environment Protective Administration in order to clarify and give direction to:

- The extent of conventional pickup service that the City might be obligated, or willing, to provide under the terms of the lease.

- WIDC contemplated allocation of installation and operating costs among developers, commercial interests, and the City.

- Who pays for the City hospital installations.

- Cost allocations with consideration of the benefits of an all-Island pneumatic collection versus separate systems for hospitals.

b. We recommend that the Swedish installations in Sundbyberg and Hallenbergen be observed first-hand and that classification and quantity data be obtained together with operating information and maintenance history. Hopefully, it will also be possible to meet with members of the Stockholm City Council subcommittee on pneumatic collection to benefit from their findings.

This will lead to "Yes" or "No" recommendation by G&H, as to whether WIDC should negotiate for Aerojet-General's proposed Phase 1 study to furnish more definitive estimates of system costs

3.6 Reclamation

Reclamation possibilities would seem to be limited to the materials presently recovered by various operations in the City. All such materials must be segregated and picked up by separate collections. All are subject to widely fluctuating markets, paper wastes in particular. Reclaimed materials could include:

- Waste paper (office and other.)
- Newspapers.
- Meat wastes.
- Clothing and furniture for Salvation Army pickup.

The extent of reclamation that will be feasible will be determined by the nature of the general collection system adopted and the amount of private collections that would be permitted. It appears that waste materials to be reclaimed should be segregated at the building source for separate pick up. These materials should not enter a central collection system from which later separation would more difficult.

4. EXISTING FACILITIES

Island installations now include two City hospitals with ancillary facilities, the City Fire Department training school, and miscellaneous structures mostly unoccupied.

With minor exceptions, all refuse is now collected by the Sanitation Department. Hospital wastes are collected daily, except Sunday, requiring about 8 to 10 trips per day. Refuse from other areas is picked up several times a week. Bulk pickups three times weekly total 3 to 5 loads. All collections are delivered to a City incinerator or marine transfer station.

The exceptions:

-Goldwater Memorial Hospital has a small trash incinerator burning about one ton of combustible rubbish per day.

-Segregated garbage from Goldwater is picked up by a private collector.

-Both hospitals dispose of their own pathological materials.

Goldwater Hospital has a central basement corridor extending for its full length. Both sides are used for storage and for access to basement wings. The corridor is used for the present collection of refuse by 4 wheel hand trucks. There appears to be sufficient height for an overhead pneumatic collection pipe.

Bird S. Coler Hospital does not have a central basement corridor. It does have an extensive pipe trench through the center of the building branching out to the various wings for utility services. The utility trench is crowded and a new pneumatic collection pipe would have to be threaded through. Refuse collection is presently done be 4 wheel hand trucks on the main floor of the building.

5. REFUSE COMPOSITION AND QUANTITY

Island refuse (Note 1) will be generated in households, commercial facilities, schools, health centers. recreational facilities and the two hospitals. Waste from secondary sources will include debris from parks and grounds, and street refuse.

5.1 Composition

Household refuse, exclusive of bulk objects. will consist of food wastes, paper, plastics, textiles, metal and glass, all sorts of miscellaneous household debris and discards. The quantity and quality will vary some with family constitution and economic level. In the aggregate, household refuse will contain more rubbish than garbage; with perhaps up to 25 to 40 percent moisture, up to 10% incombustible solids, and a heating value for design purposes of about 5,000 Btu per pound as fired. Most of this material will be dropped or stuffed through the service openings into refuse chutes. Boxes and other objects too large to fit will be left on hallway floors at each hopper.

Commercial refuse will vary with the source. On an overall basis it would be expected to contain less moisture than household refuse and have a somewhat higher heating value, up to 6,000 Btu per lb. However, this would be influenced by the proportion of food waste that will actually occur. The several varities of commercial refuse are described as follows:

- Office waste will be mostly paper plus some cartons and sweepings. It is normally collected in early evening by the building cleaners and left at service elevators or utility rooms; then on the next morning taken to a removal point by building porters.

NOTE (1): See Appendix A for glossary of terms

-Waste from general commercial areas will consist of paper and cartons, plus garbage from restaurants and food shops. Materials will be assembled at each shop for removal.

-Supermarket wastes are principally cartons with some spoiled food and glass breakage; plus butcher shop trimmings which are usually collected separately and sold for rendering.

-Hotel waste will include rubbish, garbage from restaurants and bulk objects.

-Waste from schools and community facilities will for the most part consist of combustible rubbish, plus a garbage fraction from any school cafeteria.

-The two Island hospitals, Goldwater Memorial and B. S. Coler, are extended care institutions providing for about 2300 patients. Their refuse consists of rubbish, garbage, building debris and bulk objects. It is characterized by a growing content of disposals, such as plastic utensils, plastic-backed paper sheets and diapers. Pathological wastes from hospitals and health clinic will not enter the Island refuse system and the hospitals themselves will get rid of these materials.

-Bulk items will generally consist of discarded furniture, rugs, curtain rods, crates and similar oversized materials from buildings and hospitals. These cannot be compacted or reduced except by special machinery and will require separate handling, collection and treatment. Major appliances being replaced in quantity by building owners will not usually be dis-

carded because of their salvage or scrap value.

-Miscellaneous wastes will include grass and tree clippings and dirt from the building grounds and park areas. Also, street wastes including litter baskets contents and swept debris consisting of paper rags, wood, road grit and dirt.

5.2 Trends in Composition

The present chances in urban refuse composition with time are expected to continue for the period covered in this study. The amount of garbage, or animal and vegetable wastes, will further decrease as will the moisture content. Plastic and paper fractions will rise and the "as fired" heat value with them. In many apartment households today's garbage is already minimal, consisting only of bones, rinds and cores. Practically no food is thrown away other than what clings to container interiors. It is anticipated that these minimal mounts will be further reduced by even more of the pre-trimming and pre-packaging of meat and vegetable products. Disposable clothing and household linen may come into use, further increasing total amounts of paper and plastics.

It is assumed that the Island hospitals will continue their transition to disposables and that in the near future all sheets, towels, patients bed garments and other hospital linen will be paper and plastic and that bedside equipment for patient care will be one-use plastic. Combustible content and heat value of the combined refuse will increase.

5.3 Quantity

Todays trends indicate that per capita waste generation is increasing at the rate of 4 to 5 percent annually.

For any design basis, history and prudent judgement dictate that estimates of Island refuse include a growth factor. For this study, the design year is taken as 1980 and present quantities have been increased by 50 percent.

However, efficient solutions to the solid wastes crisis to some extent require changes in national attitudes that will force some shift to an economy of durability, despite the complex adjustments involved. These, together with possible legal limitations on junk mail, non-returnable containers and one-use products could significantly change the composition and quantity of household refuse even before 1980.

a. Household Wastes

1970 residential solid waste generation in New York City approximates a total of 3.7 lbs per capita per day (Note 2) and per capita quantities are increasing in the range of 4 to 5 percent annually. Using the year 1980 as a design basis the daily generation is assumed to be 50 percent greater than today. A breakdown appropriate to highrise apartment units is estimated as follows:

	Lbs per Capita per Day	
	1970	1980
Household refuse into building chutes	2.5	3.75
Household refuse left on hallway floors at charging hoppers	0.2	0.3
Attributed to schools and community facilities	0.2	0.3
Attributed to hospitals and private institutions	0.3	0.45
Bulk wastes	0.5	0.5 (no change)

NOTE 2: Projection based on Regional Plan Association "Waste Management, A Report of the Second Regional Plan" March 1968.

Total household waste to be generated by 18,600 residents on the Island is estimated to be:

Table 1 - Daily Household Waste

Item (Note 3)		Total lbs per Day 1970	1980
A	Quantity deposited into refuse chutes	46,500	70,000
B	Daily quantity left in hallways	3,700	5,600

b. Total commercial waste generated on the Island is estimated to be:

Table 2 - Daily Commercial Waste

Item		Sq. Ft.	lbs/Ft^2 Per Day	Total lbs/Day 1970	1980
	Supermarket in motorgate	15,000	.10	1,500	2,250
	Dispersed general commercial in north town	6,000	.05+	300	600
	Dispersed general commercial in south town	4,000	.05+	200	400
	Supermarket in town center	25,000	.10	2,500	3,750
	General commercial in town center	50,000	.05	2,500	4,000
C	General Commercial Subtotal			(7,000)	(11,000)
D	Offices in town center	200,000	.02	4,000	6,000
E	Hotel in town center	300 rooms	10.0/room	3,000	6,000
	Commercial Total			14,000	23,000

NOTE 3: A, B...L Identify various waste fractions for subsequent sections of the report.

c. School and community facility waste is estimated to be:

Table 3 - Daily School and Community Facility Waste

Item				Lbs/Day 1970	Lbs/Day 1980
F	Schools	18,600 x 0.10 lb/C/D	=	1,850	2,800
G	Community Facilities	18,600 x 0.10 lb/C/D	=	1,850	2,800

d. Hospital Waste

The Island hospitals generate an estimated 10 to 15 lbs per bed per day. For design purposes this quantity is expected to be 30 lbs per bed per day by the year 1980 and the total to be split equally between the two hospitals.

Table 4 - Total Daily Hospital Waste

Item		Lbs/Day 1970	Lbs/Day 1980
	Total Waste - 2300 beds x 12 lbs/D/bed	28,000	69,000
	Estimated breakdown		
H	Chuted wastes	16,000	40,000
J	Food preparation and serving (collected)	8,000	20,000
K	General Rubbish (collected)	4,000	9,000

e. Bulk Waste

Little or no increase is expected in the quantity of non-reducible bulk and oversize items discharged from residences and hospitals, the principal origins of such material. The total amount generated on the Island in 1980 is expected to be:

Table 5 - Daily Bulk Wastes

Item		Lbs/Day
Community 18,600 persons x 0.5 = 9,300 lbs/day		
	Attributed to Households	4,600
	Attributed to Hospitals	4,600
	Add Estimated Commercial	800
L	Total	10,000

5.4 Design Values

The amounts of solid waste to be considered for the study of alternate collection systems are listed in Table 6, and the 1980 quantities are shown in Figure 1.

Table 6 - Daily Total Refuse Generation

Item	Classification	Total lbs/Day 1970	Total lbs/Day 1980	Anticipated Accumulation
A	Household chuted	46,500	70,000	20% 8-10 a.m. 60% 5- 9 p,m.
B	Household assembled	3,700	5,600	a.m. batch
C	General commercial, assembled	7,000	11,000	a.m. batch
D	Office, assembled	4,000	6,000	a.m. batch
E	Hotel, assembled	3,000	6,000	a.m. batch
F	School, assembled	1,850	2,800	a.m. batch
G	Community facilities, assembled	1,850	2,800	a.m. batch
H	Hospital chuted	16,000	40,000	50% 7-11 a.m. 30% 6- 9 p.m.
J	Hospital food preparation, assembled	8,000	20,000	33% in 3 hrs. at each meal or a.m. batch
K	Hospital rubbish, assembled	4,000	9,000	a.m. batch
	Subtotal	95,900	173,200	
L	Bulk wastes	10,000	10,000	a.m. batch
	Total	105,900	183,200	

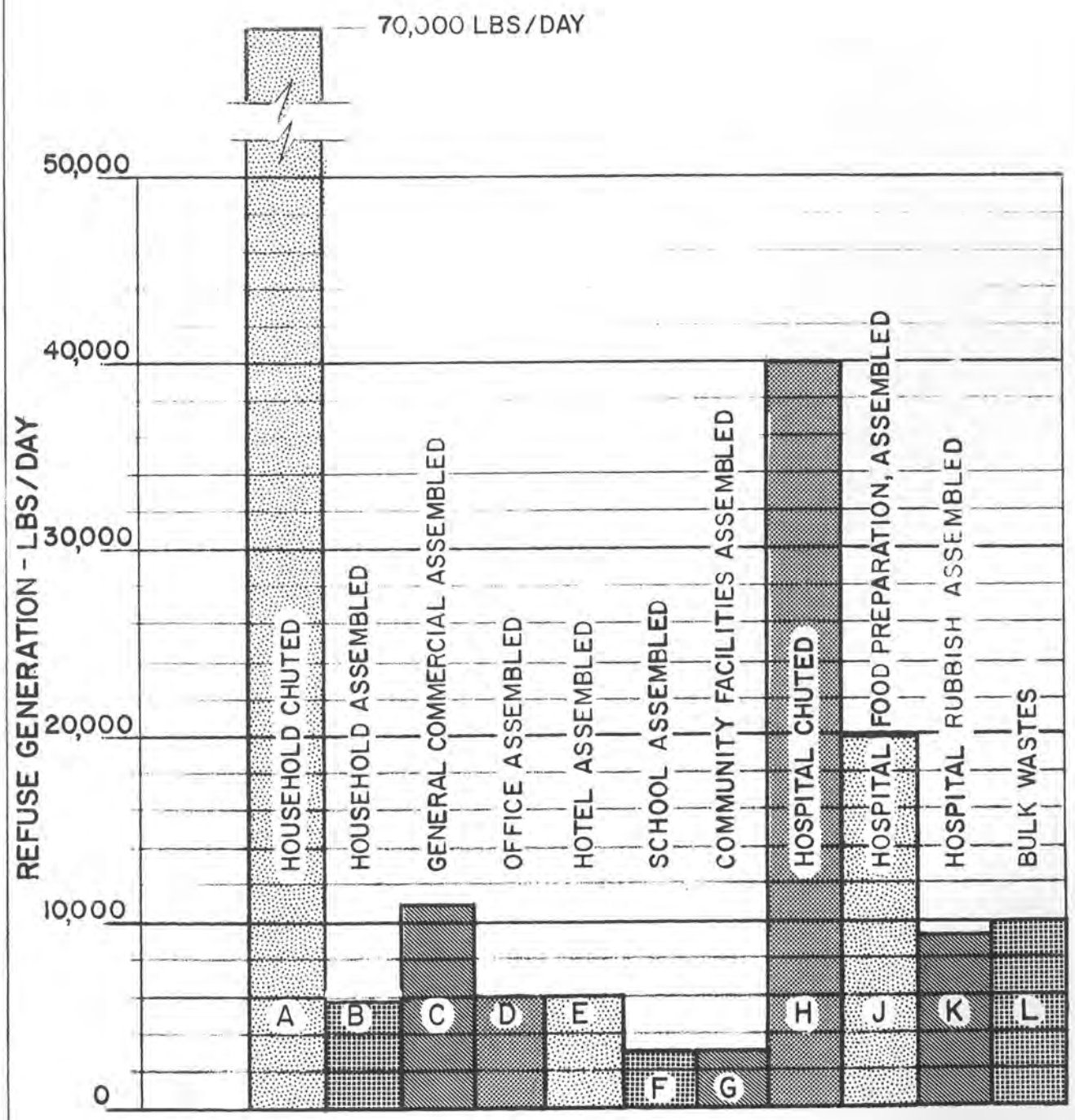


FIGURE I – DAILY ISLAND REFUSE GENERATION-(1980)

No matter what the method of collection, chuted waste from households (Item A) and hospitals (Item H) enter the Island collection system at the moment they are deposited, and the system must accommodate them right then. The estimated load vs. accumulation time is shown on Figure 2. This is based on the accumulation of these wastes as follows:

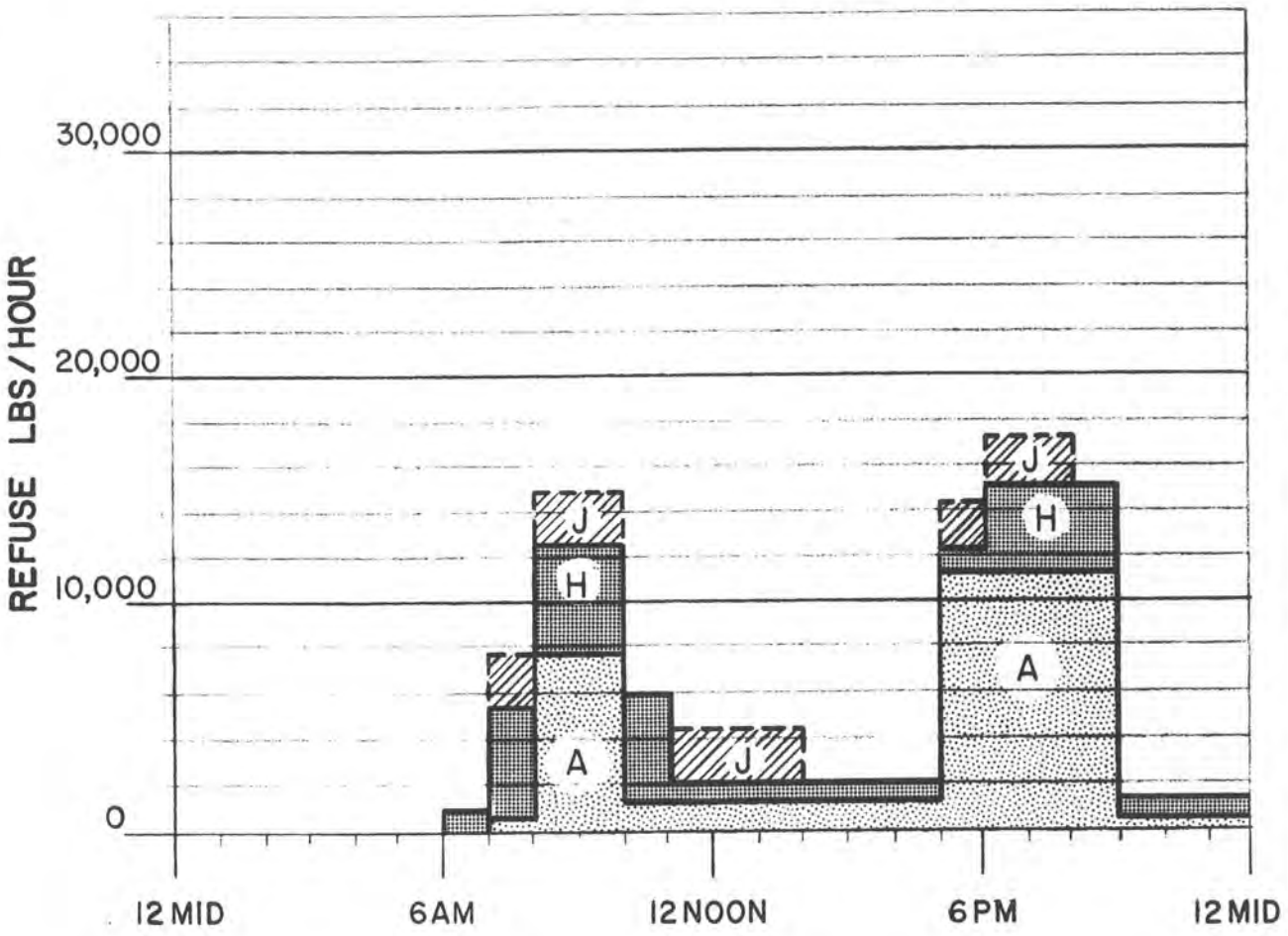
A. Household Chuted	20% from 8 to 10 A.M. 80% from 5 to 9 P,M.
H. Hospital Chuted	50% from 7 to 11 A.M. 30% from 6 to 9 P.M.
J. Hosptial	3 hrs. at each meal time

Such little deposition is expected between midnight and 6:00 a.m. that chuted wastes are considered zero.

All waste fractions other than A and H accumulate as batches in local containers or piles, for removal in the early morning. These must be re-handled in order to enter the collection system and the time of entry is therefore, controllable, independent of generation. However, waste fraction J, from hospital food preparation and commissary activities, could be discharged in three 3 hour periods, spanning mealtimes. Its additive effect on time-load factors is shown on Figure 2.

Bulk waste, Item L, consists of the oversized, non compactable objects that will require separate handling regardless of the collection system selected.

A certain and indeterminate portion of all other wastes except chuted refuse may be bulk when viewed from the particular collection system adopted. For example, large cartons and delivery boxes are bulk to pneumatic conveyors and bagging compactors until crushed or shredded.



A —— 70,000 LBS/DAY
H —— 40,000 LBS/DAY
J —— 20,000 LBS/DAY

FIGURE 2 — LOAD/TIME DISTRIBUTION-(1980)

5.5 Other Refuse Fractions

Lawn and park debris will vary from zero in winter to perhaps 3 or 4 tons per day for short and limited periods in spring and summer. The major portion will be generated in the parks and might possibly be handled by the City Park Department. In any event, the average amount is small and the material has no significance in a comparison of alternate collection systems.

Street refuse, also minimal in quantity, involves separate handling and is not a factor in any comparisons.

6. REFUSE COLLECTION

6.1 General

The Island planners' goals of a pedestrian environment would be best served by underground refuse handling. This could formulate as:

a. Pneumatic collection of chuted refuse to the central transfer station at the utility complex. Oversized cartons could be reduced by crushing or shredding and fed into the pneumatic system. Non-reducible bulk waste would be picked up separately and hauled off-Island directly or through the transfer station.

b. Container train collection, with local compactors at each chute and loading station, either filling day size containers directly or bagging for later fill. Containers on wheels would be drawn underground through tunnels as a train. Non-reducible bulk would be picked up separately.

c. Conveyor belt collection, with local bagging compactors at each chute and service point. Bagged refuse would be brought to a main conveyor belt by transverse belts or by handcarts, main belt would discharge to a central transfer station. Bulk waste would be picked up separately.

Other collection methods are not in keeping with the desired ambience or with reasonably available space. They would require pickup by trucks in loading berths within each building, or curbside collection by trucks parked or double parked in streets.

d. Local compacting loaders at each chute and service point, discharging into day-size or larger containers to be picked

up at street level, in loading berths or at curbside. Bulk waste would be picked up separately.

e. Conventional pickup practice with local bagging compactors at each chute and bagged refuse hauled out to cubside or stored in loading berths, for pickup by compactor trucks.

f. Uncompacted refuse into large containers at each chute and service point, retained in loading berths for pickup by roll-on trucks or by compactor trucks.

Ultimate collection could be a combination of several methods, depending upon agreements reached between WIDC and New York City, upon assured technology, and upon the compelling persuasions of envioronment and economics.

6.2 Bulk Waste

In all collection systems, bulk and oversized waste must be collected separately. Such material is normally picked up by the New York City Sanitation Department by appointment. A future pickup date is set with a telephone call; on this day the material is placed at curbside usually by 7:00 a.m. The collection truck is supposed to come by sometime during the day and make the pickup.

Any of the collection systems will have a room of some kind at the foot of each chute, be it valve room for pneumatic system or compactor room for others. This will also provide space for the storage of bulk material from its date of discard to the pickup day.

If the City collections are over-late, or for any other reason of environmental ambience, the WIDC may elect to collect bulk with its own manpower and vehicle and take it to the transfer station for City pickup, thus keeping it off the streets. Such vehicle should have an elevating tailgate.

6.3 NEW YORK CITY COLLECTIONS

New York City will collect residential refuse from any taxpayer. Local Law 14, 1968, requires some form of compacting for refuse from highrise buildings. The City presently limits this not to exceed a compacted weight of 700 lb. per cu. yd. City pickups are presently made from the curbside at each building. Frequency, in east Manhattan, for example, is twice a week. There does not appear to be any different collection policy yet formulated for multibuilding complexes.

Today, labor costs for refuse collection are extremely high, reportedly $28. per ton and expected to increase. A central collection point or several such, using large containers, would substantially reduce cost and greatly benefit the City. Such centralization involves new Sanitation Department equipment that is just beginning to evolve or may yet be only conceptual. It could also involve off-street loading berths at the developers expense.

The City does not collect commercial or industrial refuse. These are usually picked up by private carters, who may, if necessary, dispose combustibles at City incinerators for a fee presently about $2.50 per ton.

The extent of New York City service that Welfare Island is entitled to must be established. What are the effects or benifits from:

- Obligations and limitations of lease, if any
- Reduced cost to the City by concentrating all Island refuse at a single pickup point, the transfer station; as compared to the normal City collection from each building.
- Inclusion of commercial refuse in an all-Island system
- Separate collections for Towns and hospitals

7. PNEUMATIC COLLECTION

7.1 Description

In a pneumatic collection system refuse is drawn from building chutes and local depositories to a central collection point by an air stream moving through transport pipes at a velocity of about 5000 ft. per min.

Oversized and overweight objects must be collected by other means.

A pneumatic system is shown schematically on Figure 3. Refuse dropped into the building chutes accumulates in the lowermost section (storage) above a closed discharge gate. The collection system is started automatically, exhaust blowers and branch air inlet valves are activated, and the high velocity air stream is established. Discharge gates on each branch are then automatically opened one at a time, stored refuse drops by gravity into the air stream and the gate then closes. The material is carried to central collection hoppers in the transfer station where it drops out for removal into compactors. The air is drawn through dust filters and then passes through the blowers and through discharge silencers, exhausting to atmosphere.

The operating cycle is automatically regulated by a central control system that sequences the valve operations and that can be programmed for varying demand situations or can override if excess materials build up at any point. Controls can be arranged to indicate operating status and annunciate malfunction.

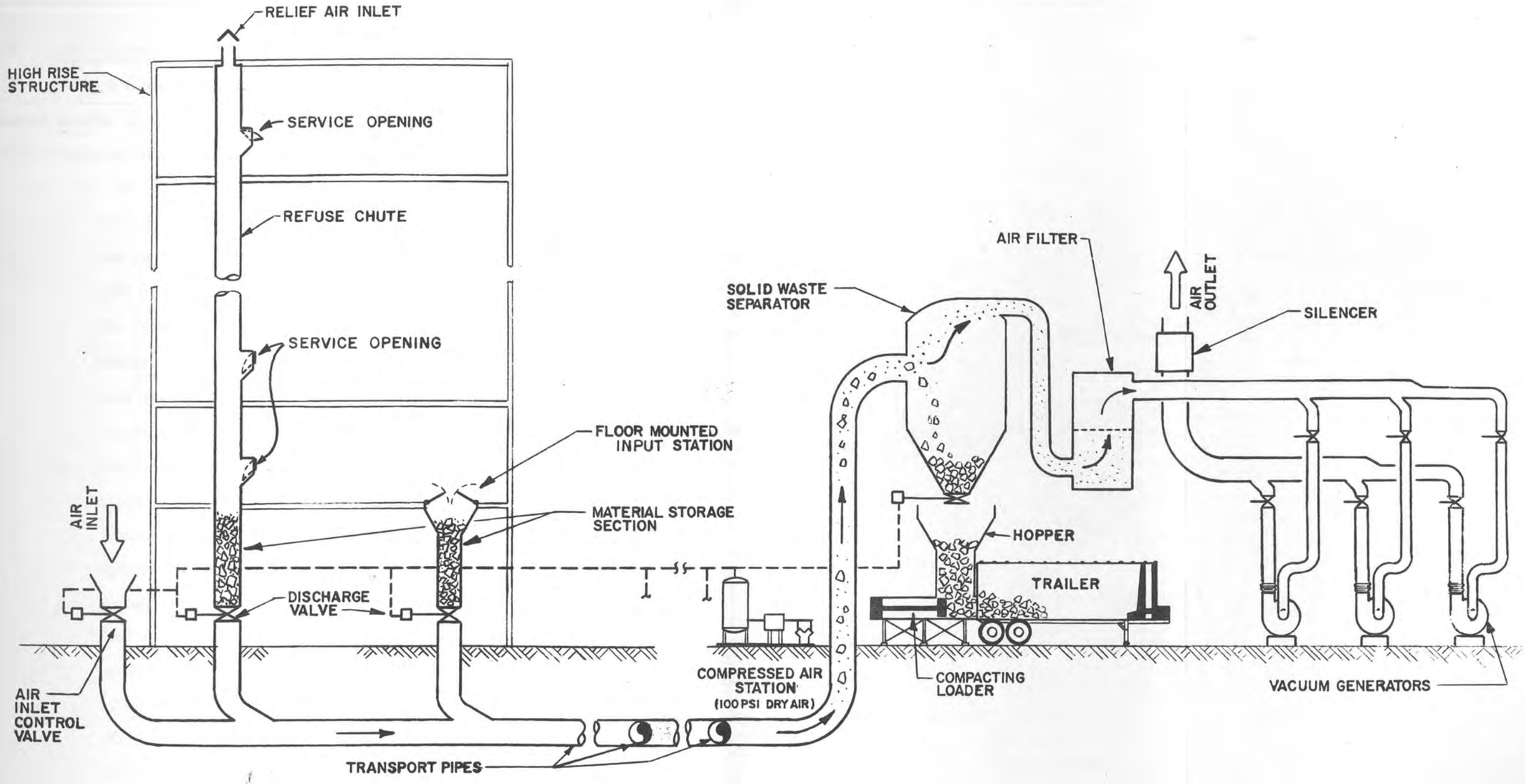


FIGURE NO. 3

PNEUMATIC REFUSE COLLECTION SYSTEM

7.2 AVAC System

AVAC is a pneumatic system developed by AB Centralsug, a Swedish Company located in Stockholm. It is manufactured under license by Aerojet-General Corporation of El Monte, California. Aerojet General representatives have provided the following information.

a. In Sweden, the first pneumatic refuse collection system was installed at the Solleftea Hospital, operational in 1961.

b. The first residential area to be equipped with Centralsug's pneumatic system was a district in Sundbyberg, serving 1100 apartments in a low rise building complex; operational in 1967 and now being expanded to 5000 households.

c. Centralsug is now installing 10 systems in Sweden including: Hallonbergen, 2000 flats, now undergoing startup tests; and Brandenbergen, 3600 dwelling units. Ten more systems are presently being planned.

d. A committee report to the Stockholm City Council recommends that a pneumatic collection system be installed in a projected residential area in North Jarvafaltet in lieu of conventional truck pickup. Initial cost is estimated at SKr 39.5 million (US $7,650,000), and the system would ultimately collect residential and commercial refuse from about 32,000 people. The committee states that a pneumatic system could move refuse a full 2.5 kilometers (1.5 miles). The City Council is reported to have accepted the recommendation.

e. In the United States, Aerojet is presently installing an AVAC system in the Martin Luther King, Jr. General Hospital, Los Angeles, California and one for rubbish in Walt Disney World, Orlando, Florida, where the longest run will be 6000 ft. They are under contract to install a system for the Shadyside Hospital addition, Pittsburgh, Pennsylvania. Negotiations are presently being conducted for trash and linen system for the Mount Sinai Hospital, New York City.

f. The first US installation of an AVAC system for residential refuse is contemplated for Mutual Redevelopment Houses, Inc., an existing high rise multibuilding complex of 2820 apartments in 10 buildings (15 cores) on a 30 acre site in midtown Manhattan. The project is now at the point of renegotiating with the government to transfer and add an additional sum to the prior Federal demonstration grant of $568,000 for Warbasse Housing. These grants are usually two-thirds of cost so it is surmised that the Mutual installation will cost about $1.1 million.

g. Aerojet-General has a small test and demonstration system installed at their plant in El Monte, California.

7.3 Limitations

Little or nothing is known here about the capabilities, limitations or operation of AVAC in residential refuse service. The one operative installation, at Sundbyberg, serves 1100 flats in low rise buildings where about thirty apartments are connected to each chute. It is understood that the system operates only three cycles per day, on timer control.

Sundbyberg would appear to be handling very little refuse.

Additional information about AVAC is necessary before any valid assessment that can be made or any recommendation for Welfare Island can be considered. This would include:

-report on composition and amounts of refuse being handled in Sundbyberg, Sweden,

-operating and maintenance records, particularly as regards blockage and erosion, and

-first hand observation of the Sundbyberg and Hallonbergen facilities in operation.

Welfare Island household refuse will contain anything that can be dropped or stuffed into a building chute. The pneumatic system must provide for the transport or convenient removal of:

-high density objects: electric irons, lantern batteries, lead flower holders, liquid filled containers, and

-bulky objects; tightly rolled carpeting that could come undone in the transport tube and long metal pieces angled in through the service openings that might land up in discharge gates and charging openings.

Equally important, the uphill transport capability for mixed residential refuse must be assured, since the terminal end of the Island system would be elevated well above grade in order to provide gravity discharge into proposed transfer station facilities.

Pneumatic system capacity is essentially determined on a volumetric basis in that, in a given interval of time (approximately 30 seconds) one discharge gate opens and releases its volume of stored material (approximately one cubic yard). The density or this material in the storage section determines the capacity by weight of the system. Without operating data, including densities and character of refuse handled by prototype installations, there could be a large gap between estimated and real capacities.

7.4 AVAC Pricing

Aerojet-General for its bid price furnishes and installs their system complete and ready for operation, including piping valves, storage sections, connections to building chutes, wiring, instruments and controls. They do not do any civil work, so that all; tunnels, pipe trenches, excavation, back fill and related items necessary to construct or complete their pathway is additional to their work.

They manufacture themselves or purchase various items differently around the country; they assemble installation subcontractors at all ranges of labor cost and all sorts of union requirements depending on job location.

Aerojet-General representatives advise that it is very costly for them to make a bid, and far more so to make a firm quotation, either of which may not be accepted. These expenses must be recouped, particularly in view of the widespread interest in the system and the many requests for cost data. Their representatives advise G&H that they would provide service to WIDC in stages, as follows:

Phase 1. A Definition Study to establish design criteria, preliminary system engineering and preliminary cost estimates. In this study Aerojet-General will:

a. Develop their operational criteria, valve and line sizing, operating cycles, control methods, silo sizing and system capacities.

b. Establish an incremental development plan and

analyze incremental installations at part of a master plan. Analyze equipment combinations, line combinations, power and control combinations during growth of system; all in view of cost trade-offs to make their total bid as low as possible.

c. Preliminary system layout drawings, standard details and a breakdown budget estimate.

Phase 1 produces their estimated cost to the customer, to ± 10 per cent, together with a comprehensive system report. Aerojet-General would do this work for a fee to them of $20,000 to $25,000, in a time of 6 to 8 weeks.

If Phase 1 is accepted, Aerojet-General would then develop their firm quotation in Phase 2 as follows:

Phase 2. Either:

a. Negotiate the price for a complete installation, or

b. Negotiate the cost of a detail contract for a first incremental system such as North Town. This now will give complete system design and a firm Aerojet-General quotation to construct this portion of the work. If the quotation is accepted, this portion will go ahead. If the price is not accepted, they have been paid for their effort.

Phase 3. A system in stages as "b" above would be extended in like manner.

Aerojet-General has advised G&H that they would guarantee the performance of their system.

7.5 Island Pneumatic System

Pneumatic refuse collection for Welfare Island is envisaged below.

Lacking performance data and demonstrated values, system capacity would be based on a conservative material density as stored in the chute. The Island refuse load would seem to require two separate systems, both terminating at the transfer station in the utility complex. Each system would serve one hospital and about one-half of the residential and commercial load. Each would be complete with separate exhaust blowers, air filters and controls; operating horsepower would approximate 500 hp each. The systems would be interconnected for flexibility and spares would be interchangeable.

Maximum run from Goldwater Hospital to utility complex would be about 6,000 ft. Exposed transport pipe in tunnels and basements would be covered with acoustic insulations. Buried pipe would be bituminous coated and wrapped. Cleanout and access openings would be provided at 250 to 300 ft. intervals and elsewhere as required.

Service openings into building chutes would be of limited size. Chutes would be equipped with high temperature alarms and sprinklers for fire protection. Detectors would override the system operating sequence to remove burning material immediately.

Controls would be flexible and permit variations in operating cycle to meet shifting demands. High rise buildings would be cycled more frequently than low units.

A tentative collection system is shown on Figure 4.
As yet there are no definitive building and core arrangements so that this layout is only an order of magnitude portrayal.

Building chutes for the most part are shown discharging directly into main branches. Alternate Christmas tree arrangement with branches all stemming from main transport pipes in the tunnels is also feasible at some reduction in system capacity. This layout is shown in Figure 5.

Where pipes pass through or beneath buildings, they are assumed to be in pipe tunnels, If not, other definite building foundation provisions must be made so that pipe can be removed and replaced.

Discharge valves at chutes would be located in sound-insulated rooms. Sufficient floor space would be provided for auxiliary containers to receive refuse diverted from the chute in case of local breakdown blockage or system outage.

Cartons collected from the hallways of apartment buildings would, for the most part, be small enough to be crushed by trampling or torn by hand and fed into the system through an enlarged input opening in the valve room by building porters. The few truly oversize cartons could be treated as bulk and removed by separate pickup. A possible alternate would be shredding stations in several central buildings to which such cartons could be taken for reduction and injection into the pneumatic system.

Most of the office, school and community facility wastes could be fed into the system through large, floor-type input stations.

Conveniently located shredding stations would be provided to reduce supermarket and commercial wastes as necessary, plus whatever portion of other waste fractions also required.

7.6 Operation

Capacity of the Island system is reasoned to approximate the following.

Each discharge gate cycles "open-dump-close" in 30 seconds, releasing one cubic yard of material into the transport pipe.

In a span of 60 minutes, there would be an estimated 45 minutes available for gate cycling, or 90 operations. About 15 minutes would be used: to dump central collecting bins into truck loading compactors; as additional time for branch air inlet valve change overs; and in cycle interruptions for local demand situations.

The hourly capacity will approximate 90 dumps, or 90 cubic yards. If the material accumulated at the bottom of each chute weighs 100 lbs per cu yd , capacity will be 9000 lbs. per hr. If it weighs as much as 150 lbs per cu yd , capacity would be about 14,000 lbs. per hr.

A dual system serving the entire Island would be expected to have a capacity from 18,000 to 28,000 lbs. per hr. Aerojet-General's Phase 1 Definition Study would establish the real timing factors, but only demonstrated operation over time will prove the true range of that inconstant number, i.e., the weight of a cubic yard of refuse in the AVAC storage section at the bottom of an apartment house or hospital chute.

The central collection bins would be discharged to compactors after each sweep of the Island and the system would then shut down unless otherwise directed by pre-taped program for peak hour service, or by demand override of the control system.

With two systems serving about 35 chutes each, a complete operating cycle or Island sweep would take about 20 to 25 minutes. It is expected

that systems will operate almost continuously during the 6 hours of peak production (see Figure 2), about twice between 10 p.m. and 6 a.m., and about one-third time during the remainder of the day. Total operating time is estimated to be 11 hours per day.

7.7 Other Manufacture

AIR-FLYTE is a pneumatic system for linen and trash collection, manufactured by Eastern Cyclone Industries, Fairfield, New Jersey. There are many single and dual installations in hospitals, universities and commercial plants variously handling linen or trash.

They have no systems now handling residential refuse, nor any designed for such material. Air-Flyte has therefore not been considered for Welfare Island at this time.

8. OTHER COLLECTION SYSTEMS

AVAC must be measured in comparison with alternative systems. Four such are described below and are shown schematically on figure 6. Each assumes the same number of gravity chutes or loading stations as pneumatic collection, i.e., 50 residential chutes, 9 commercial stations and 12 hospital stations.

8.1 Container Train

Compacted refuse is transported in containers drawn by an electric powered tractor that would pull several units at a time through underground tunnels to the utility complex; where the containers are dumped into receiving bins, washed and returned.

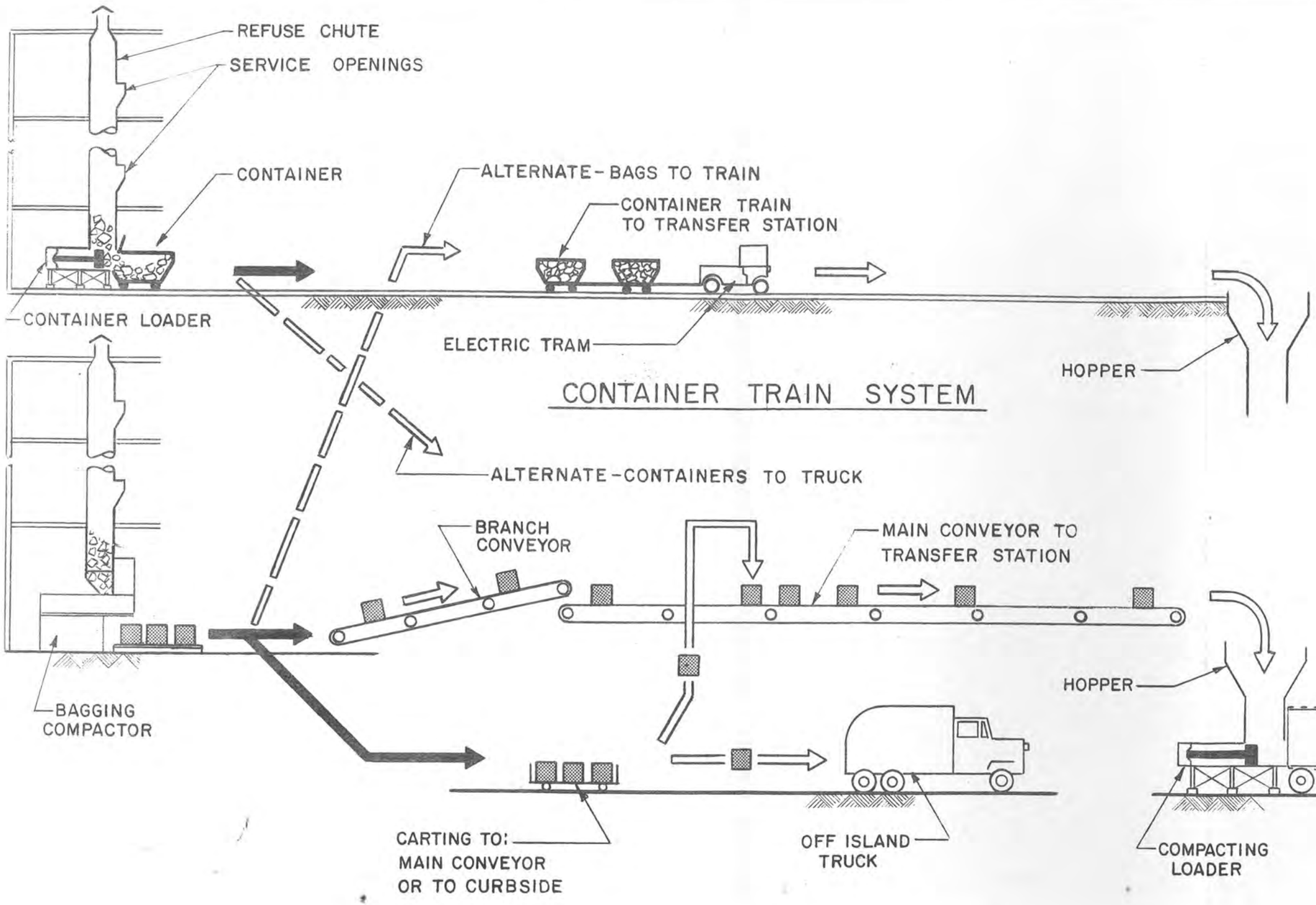
Containers are wheeled, with pneumatic tires. They would be day-size units of about 2,000 lb. capacity, directly loaded by compactors beneath each chute and input station. This would involve development of suitable containers and assemblage of proper ancillaries so that:

-a closed container withstands compacting pressures.

-it opens easily and remains open during a tilting or an upside down dumping cycle, and during a tilting wash-down cycle with pressurized hot water and deodorant, and

-the container closes easily and locks in for refill.

Underground collection by motorized train would require; main tunnels from the utility complex to system limits, a basement compactor room at each building core and input station, and branch tunnels connecting all such rooms to the main tunnels. Basement rooms would be large enough to store spare containers and to turn and maneuver.



BAGGED REFUSE SYSTEMS

FIGURE NO.6

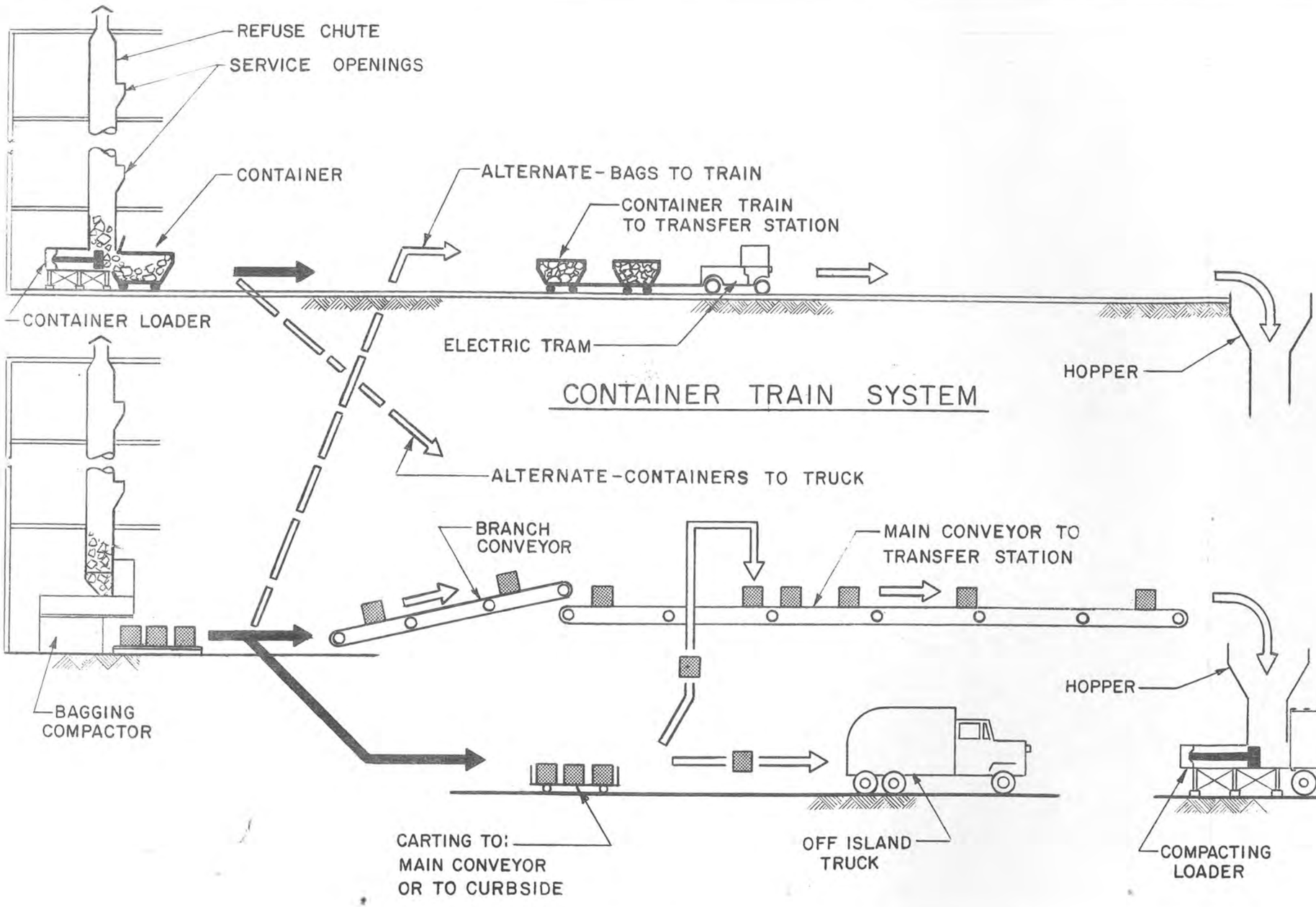

REFUSE CHUTE
SERVICE OPENINGS
CONTAINER
ALTERNATE-BAGS TO TRAIN
CONTAINER TRAIN
TO TRANSFER STATION
CONTAINER LOADER
ELECTRIC TRAM
HOPPER
CONTAINER TRAIN SYSTEM
ALTERNATE-CONTAINERS TO TRUCK
BRANCH
CONVEYOR
MAIN CONVEYOR TO
TRANSFER STATION
BAGGING
COMPACTOR
HOPPER
TRANSFER
STATION
CARTING TO:
MAIN CONVEYOR
OR TO CURBSIDE
OFF ISLAND
TRUCK
COMPACTING
LOADER
OFF ISLAND
TRAILER
BAGGED REFUSE SYSTEMS

FIGURE NO.6

The residential load will break down as follows:

	1970 lbs/Day	1980 lbs/Day
A. Chuted refuse	46,500	70,000
B. 95% of hallway pickups fed into compactor	3,600	5,400
	50,100	75,400
Each of 50 chutes, per chute	1,000	1,500
Number of containers per chute	1 per day	1 per day

Two 2-man crews would disconnect and close the containers, clean up, and reconnect an empty to the compactor, using a Tow-motor or by pushing.

One 2-man crew would make up and operate a train of four containers, one from each of four compactor rooms.

One 4-man crew at the transfer station would dump and wash containers and spot empties for pickup.

e. In the United States, Aerojet is presently installing an AVAC system in the Martin Luther King, Jr. General Hospital, Los Angeles, California and one for rubbish in Walt Disney World, Orlando, Florida, where the longest run will be 6000 ft. They are under contract to install a system for the Shadyside Hospital addition, Pittsburgh, Pennsylvania. Negotiations are presently being conducted for trash and linen system for the Mount Sinai Hospital, New York City.

f. The first US installation of an AVAC system for residential refuse is contemplated for Mutual Redevelopment Houses, Inc., an existing high rise multibuilding complex of 2820 apartments in 10 buildings (15 cores) on a 30 acre site in midtown Manhattan. The project is now at the point of renegotiating with the government to transfer and add an additional sum to the prior Federal demonstration grant of $568,000 for Warbasse Housing.

g. Aerojet-General has a small test and demonstration system installed at their plant in El Monte, California.

8.2 Conveyor Belt

Compacted refuse in 65 lb bags is transported on conveyor belts in main tunnels to the central transfer station in the utility complex. It is brought from basement compactor rooms to the belts on carts drawn by tow-motors or by transverse feeder belts. The extent of required underground tunnels is about the same as for the container train.

Bagging compactors beneath each residential chute discharge 65 lb slugs into plastic or paper bags. The machine automatically fills about 10 bags which are removed manually, tied closed and replaced with empties. Compactors stop automatically when all bags are full and so must be serviced at least three times a day to assure continued operation.

The residential load will break down as follows:

	1970 lbs/Day	1980 lbs/Day
A. Chuted refuse	46,500	70,000
B. 90% of hallway pickups fed into compactor	3,300	5,000
	49,800	75,000
Each of 50 chutes, per chute	1,000	1,500
No. of 65 lb bags per chute	15 bags/day	23 bags/day

One would remove full bags from a compactor, tie and stack them and replace with empties. This would be done at various periods during the day at an efficiency of about 65 percent including travel between compactor rooms.

Using transverse belts, one man could load the belt with all full bags from a compactor room and then travel to the next unit.

Handling time for the transverse belt system is estimated to be

	Man-Minutes	
	1970	1980
Handle bags (3 or more visits)	30	40
Feed transverse conveyor (1 visit)	10	15
Inspect transfer to main belt	2	2
	42	57
Tons per day	0.5	0.75
Man hrs/ton at 65% efficiency	2.2	1.8

8.3 Large Container Pickup

Refuse either compacted or loose, would be deposited in very large containers, from 8 cu yd pickup size to 20 cu yd roll-on type. Pickup would be made at street level by City or private carters using special trucks not yet in general residential refuse service.

This system would require loading berths within buildings, or large containers which would stand at curbside to be picked up and dumped into the collection vehicles.

Large container pickup does not fit the Welfare Island concept, its building arrangements, or street and roadway space allocation. It might be appropriate for each of the two hospitals as a direct service, independent of town collections. In such case, material would be hauled off-Island directly by the pickup vehicles, without any transfer at the utility complex.

It might also be feasible to install a large compactor and container indoors, central to the principal commercial areas and for their use. This too would be picked up and hauled off-Island independent of the Town collection system.

8.4 Conventional Pickup

Conventional curbside pickup by City vehicles is not compatible with Island planning concepts. It is included only for comparison with the other methods discussed previously in this report.

In conventional City pickup, refuse is collected about twice a week. Bagging compactors are installed at each apartment chute or charging point and bagged refuse is retained in the compactor room. Bags are carried out and remain curbside until pickup. The city sanitation truck stops, usually double parked, the crew loads the tailbox manually, this load is compacted into the body and the vehicle moves on to the next pickup.

Handling time by WIDC manpower is estimated to be about 2.5 man-hours per ton to service bagging compactors and transport material to curbside.

The method may be slightly improved in the future by using wheeled containers that could be mechanically elevated by the collection vehicles. However, it would appear that the future trend of street level pickups from high rise buildings will be to large containers in off-street loading berths.

9. RECLAMATION

Reclamation is a part and parcel of total solid waste management. Paper, ferrous and non-ferrous metals, rubber, textiles and plastics are recovered and re-used to varying degrees in this country, and this re-cycling does reduce the accumulation of solid wastes. The problems which limit recycling are twofold:

First, reclamation is a profit-motivated business operation that has thus far been limited to processing of marketable materials that can be purchased or collected in an unmixed state.

- It has been estimated that some 10 million tons of paper stock are uncovered and reprocessed each year, representing 25 per cent of the raw material supplied to the paperboard industry. From a conservation view, the reclamation and reuse of paper stock spares grown trees and frees forest land for other uses. It is said that 118 lbs. of salvaged newspaper spares one tree.

On the other hand

- Junk cars are now a drug on the market because they can no longer be profitably hand dismantled, and reduction by open field burning is a heavy air polluting operation. The trend is toward giant shredding machines which reduce an entire car to fist size particles. Hopefully, means will be found to economically separate metals from non-metals and further separate and recover the various non-ferrous metals.

The second problem is that the complexity of mixed municipal refuse makes reclamation economically unattractive with present technology. Attempts at reclamation in the greater metropolitan area have all been abondoned and there

are none known to be operating today. However, research is proceeding.

- Numerous experiments are being conducted on separation of salvageable materials from mixed refuse. These are for the most part relatively crude practical attempts to reduce costs to a profitable level, or investigation of sophisticated devices such as magnetic or ballistic separators to salvage some particular element of refuse. Economic factors have limited the practical application of these methods.
- In another approach, the Stanford Research Institute is experimenting with a laboratory-sized air classification system. They have been successful in separating mixed refuse that is first prepared by shredding, with additional drying and screening, as necessary.
- Reclamation of incinerator residues is being studied by the Bureau of Mines in Washington D.C., Atlanta, Georgia and New Orleans to determine the costs of salvaging residues which predominently consist of metal and glass. Not surprisingly, because it is easier to separate raw materials from refuse after it has been reduced by burning, the outlook for salvaging from incinerator residues appears to be brighter than that for salvaging from raw municipal refuse.

A third problem, particularly relating to Welfare Island is that the collection of reclaimable unmixed refuse will increase the curbside or road level pickups at the expense of Island ambience. Alternately, if these materials enter a pneumatic collection system or any other underground transport to the central refuse transfer station, they must be identified, separated out and handled in their own facilities.

Reclamation in the aspects that may pertain to Welfare Island, is discussed below. It will also be further studied during the final design of a specific Island collection system, at which time feasibility or compatibility can be defined.

9.1 Waste Paper From Offices

Segregated waste paper from offices and commercial operations, including some corrugated, can be sold to board mills under varying market conditions.

In New York this waste is collected by private carters, who charge a low fee, about $5 to $7 or so per ton and then sell, or warehouse for a better market. It is believed that the profit margin is low and carters without warehouse space frequently have no market and must pay the City a fee to incinerate. Collection charges to customers are likely to increase. It also appears that there is presently an excellent market for scrap IBM cards.

On Welfare Island, uncontaminated paper waste may be estimated as:

Item	Lbs/Day 1970	1980
D. Offices	4,000	6,000
E. Hotel - 20% of total	600	1,200
Total -	4,600	7,200

If these were collected by a private carter, one vehicle trip per day would be required.

Additional waste paper from schools and community facilities might be available to the extent of another 3,000 lbs per day. These would enter the Island collection system.

9.2 Newspaper Waste

Newspapers have a separate and variable market into paper mills but only if they are segregated. If mixed with magazines and other paper they can be sold to board mills under the same category as office paper.

Newspaper waste is generated in the household. In high rise apartment buildings the mechanics of separation and assemblage are based on continued requests to the tenants, and a habit formation.

In buildings where the service opening into refuse chutes are located in walk-in cubicles, a side shelf is provided and a prominent sign is posted at the charging hopper to the effect: "Please Do Not Drop Newspapers - Leave Them on the Adjacent Shelf."

- The problem with walk-in cubicles is that certain angry tenants will dump garbage on the floor. Also there is inducement for graffiti.

Where the refuse chute openings are in the building hallways, immediately behind concealing doors, the tenants must be circularized and appealed to, on the order of "Please Deposit Newspapers - On the Hallway Floor at the Refuse Chute - In the Morning Before 8:00 a.m."

- This method requires a continued promotional campaign. It produces a lesser quantity than the cubicle supply because the hours are more restricted.

The accumulated newspapers are removed by the building porter and carried downstairs to the refuse room. They must be then picked up in a separate collection.

There are no statistics appropriate to the Island. In order of magnitude the deposition of collectable newspapers might range form 10,000 lbs/week or less to as much as 50,000 lbs. depending on tenant response to

the promotional campaign, economic levels and other factors.

Unless the building porters benefit extra from the sale of this paper, it is difficult to see how they would maintain interest in the additional work and a good portion or even all of the deposited material is expected to end up inside the refuse chute.

9.3 Mixed Commercial Refuse

Mixed refuse from supermarkets, all sorts of stores and the hotel, would have a very uncertain salvage value or more likely none at all. These wastes are estimated to be:

Item	Lbs/Day 1970	1980
C. General Commercial	7,000	11,000
E. Hotel - 80% of total	2,400	4,800
Total	9,400	15,800

If these were collected by a private carter, one or two vehicle trips per day would be involved.

9.4 Meat Waste

Fat, trimmings and other meat wastes are bought and collected from butcher shops by the Vaniderstine Company. The waste is reduced and the end products are recycled into the economy. Pickups would be one vehicle trip every second day.

9.5 Salvation Army

The Salvation Army will collect furniture and household discards that are in good condition and resellable. This material never appears in the bulk waste statistics.

They also collect clothing, reclaiming useables, and selling the remainder as textile waste.

Salvation Army pickups will be separate and would be additional to any material quantities or vehicular activities discussed in this report.

10. COSTS

In comparing costs of the several collection systems the following assumptions are made:

-Since building cores have not been established, comparisons are based on the assumption of 50 residential gravity chutes, 9 commercial input stations and 12 hospital input stations. These are indicated on Figures 4 and 5 and are the same in all systems.

-Vertical gravity chutes are a part of the buildings and their cost is not included.

-The cost of separate collections for bulk refuse is the same in all systems and is not included.

-The amounts of waste handled are the 1980 quantities.

-Amortization is: Structures, 40 years; equipment, 20 years; container compactors, 10 years; wheeled containers, 5 years. Interest rate is 7.2 percent.

-Payroll estimates are based on a labor rate of $5.00 per hour including 25 percent overhead.

-Engineering costs are included in this estimate.

-Electric rates from Con Edison Service Classification No. 13 using incremental figures.

-Cost of land has not been included.

10.1 Direct Line Pneumatic System

In this system, shown on Figure 4, building chutes and input stations discharge directly into main transport pipes and horizontal branching is a minimum. Pipes would cross beneath buildings in tunnels and outside pipe would be buried.

A dual system is assumed in accordance with Aerojet-General's preliminary information. It would include: transport pipe, discharge valves and storage chutes, air inlet valves, central collection bins, a dual vacuum generating station with air filters and exhaust blowers, control system, a compressed air system for valve operation, and several shredding stations for reducible corrugated bulk.

	Towns Only	Add for Hospitals	Total All Island
a. First Cost	$ 6,895,000	$ 1,495,000	$8,390,000
b. Interest & Amortization	590,000	140,000	730,000
c. Payroll	42,000	14,000	56,000
d. Power	30,000	13,000	43,000
e. Maintenance	35,000	15,000	50,000
f. Annual Cost			
Interest & Amortization (b)	590,000	140,000	730,000
Operation (c + d + e)	107,000	42,000	149,000
Total Annual Cost	$ 697,000	$ 182,000	$ 879,000

10.2 Branch Line Pneumatic System

In this system, shown on Figure 5, building chutes and input stations discharge into branch lines. Pipes beneath buildings are in tunnels. The main runs are assumed to be outside, buried pipe for the purpose of this estimate.

More pipe and a greater number of air inlet valves and pipe line junctions are required to serve the Towns than in the direct line arrangement in Section 10.1 above. In other respects the two are the same.

	Towns Only	Add for Hospitals	Total All Island
a. First Cost	$7,760,000	$1,500,000	$9,260,000
b. Interest & Amortization	663,000	140,000	803,000
c. Payroll	42,000	14,000	56,000
d. Power	30,000	13,000	43,000
e. Maintenance	35,000	15,000	50,000
f. Annual Cost			
Interest & Amortization (b)	663,000	140,000	803,000
Operation (c + d + e)	107,000	42,000	149,000
Total Annual Cost	$ 770,000	$ 182,000	$ 952,000

10.3 Container Train System

In this system, shown schematically on Figure 6, building chutes and input stations discharge into basement compactors which load large wheeled containers. These are hauled by electric powered tractors through underground tunnels to the central transfer station wherein they are dumped, washed and returned.

	Towns Only	Add for Hospitals	Total All Island
a. First Cost	$10,410,000	$2,340,000	$12,750,000
b. Interest & Amortization	870,000	217,000	1,087,000
c. Payroll	165,000	120,000	285,000
d. Power	5,000	4,000	9,000
e. Maintenance	15,000	5,000	20,000
f. Annual Cost			
Interest & Amortization (b)	870,000	217,000	1,087,000
Operation (c + d + e)	185,000	129,000	314,000
Total Annual Cost	$ 1,055,000	$ 346,000	$ 1,401,000

10.4 Conveyor Belt System

In this system, shown schematically on Figure 6, building chutes and input stations discharge into bagging compactors installed at basement level. Bagged refuse is transported through tunnels on lateral and main line belt conveyors to the central transfer station where it is discharged.

	Towns Only	Add for Hospitals	Total All Island
a. First Cost	$13,750,000	$2,450,000	$16,200,000
b. Interest & Amortization	1,110,000	202,000	1,312,000
c. Payroll	168,000	113,000	281,000
d. Power	7,000	4,000	11,000
e. Maintenance	60,000	20,000	80,000
f. Bags	75,000	60,000	135,000
g. Annual Cost			
Interest & Amortization (b)	1,110,000	202,000	1,312,000
Operation (c+d+e+f)	310,000	197,000	507,000
Total Annual Cost	$1,420,000	$ 399,000	$ 1,819,000

10.5 Conventional Pickup

In this system, residential building chutes discharge into bagging compactors, commercial and hospital chutes into the other suitable compacting machines. Bagged refuse is stored in compactor rooms until the pickup day, then brought to curbside for collection by the City.

	Towns Only	Add for Hospitals	Total All Island
a. First Cost	$1,640,000	$ 340,000	$1,980,000
b. Interest & Amortization	156,000	35,000	191,000
c. Payroll	185,000	135,000	320,000
d. Power	3,000	3,000	6,000
e. Maintenance	15,000	5,000	20,000
f. Bags	75,000	-	75,000
g. Annual Cost			
Interest & Amortization (b)	156,000	35,000	191,000
Operation (c+d+e+f)	278,000	143,000	421,000
Total Annual Cost	$ 434,000	$ 178,000	$ 612,000

10.6 Comparison

Pneumatic collection would be the most economical underground method and it requires less labor than any of the others.

The branch line system could be run in general utility tunnels, at a small loss in system capacity. Other collection systems would be restrictive:

- Container trains need access to all buildings and would force other utilities overhead.

- Conveyor belts would block access to and passage along tunnels.

11. CONCLUSIONS

1. A central underground collection system would be compatible with the Planners intent to achieve a pedestrian environment. It would minimize the noise, litter, odors, unsightly curbside piles, traffic blockage and high labor costs associated with conventional urban refuse collection.

2. Several types of underground systems have been evaluated:

   - AVAC pneumatic
   - container train, and
   - conveyor belt

   AVAC would be the least costly to install, requires less manpower and would be the least costly to operate.

3. None of the underground systems are presently operating in the United States on any sizable installation. The AVAC system is operating in Sweden and should be further investigated to:

   - define quantities and classifications of refuse handled, and system capabilities.
   - define operating and maintenance history.
   - determine any problem areas which might be improved through design modifications.

4. If investigation of the Swedish installations proves favorable, the U.S. licensee, Aerojet-General should be asked to prepare estimates to better define initial costs of a possible Welfare Island installation. This would require a contract for such Aerojet-General services.

5. Negotiations should be started with the City of New York to:

- define the extent of collection service that the City would ordinarily be obligated to provide.

- negotiate for City participation in costs of a central underground collection system in lieu of the ordinary truck collection with the City is obligated to provide.

- negotiate for City funding of costs of extending central collection services to the hospitals.

- define charges for including commercial wastes in the central collection system, such wastes are not usually transported in City vehicles and there is a charge for burning in City incinerators, and

- negotiate for City participation in costs of a central transfer station from which refuse would be trucked to a City incinerator.

Respectfully submitted,

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GLOSSARY OF TERMS

Bailing - a process designed to produce a compact module which facilitates ease of handling while accomplishing some compaction.

Combustible Rubbish - miscellaneous burnable materials. In general, the organic component of rubbish.

Commercial Refuse - solid wastes from wholesale, retail or service establishments, including restaurants, hotels, shopping centers, office buildings and warehouses. It also includes restaurant or cafeteria wastes from industrial concerns.

Compacting - a process to reduce volume by the application of mechanical devices for primary purpose to squeeze more materials into less space for storage, hauling, or disposal.

Construction and Demolition Wastes - waste building materials and rubble resulting from construction, remodeling, repair, and demolition operations on houses, commercial buildings, pavements, and other structures.

Garbage - wastes from the preparation, cooking and serving of food, market wastes; wastes from handling, storage and sale of produce.

Household Refuse - all types of solid wastes which normally originate in a residential household or apartment house.

Incineration - a process of burning solid, semi-solid, or gaseous combustible wastes to an inoffensive gas and a sterile residue containing little or no combustible material.

Industrial Refuse - solid wastes from industrial processes and manufacturing operations, such as: food-processing wastes, wood, plastics, metal scrap, etc.

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

Non-combustibles - inorganic solid wastes, such as tin cans, heavy metal, glass, crockery, dust, ashes, etc.

Reclamation - the controlled removal of reusable materials.

Refuse - See "solid wastes"

Residue - solid materials remaining after burning, comprising ash, metal, glass, ceramics, and unburned organic substances.

Rubbish - nonputrescible solid wastes, including ashes, consisting of both combustible and noncombustible wastes, such as paper, cardboard, tin cans, yard clippings, wood, glass, bedding, crockery, or litter of any kind.

Salvaging - See "reclamation"

Shredding - A process designed to accomplish volume reductions by breaking individual pieces of waste into small modules thereby better utilizing available space.

Solid Waste(s) - garbage, rubbish, and other discarded solid materials, including solid waste materials resulting from industrial, commercial, and agricultural operations, and from community activities. For purposes of this report, radio-active wastes are not included.

Street and Alley Cleanings - street sweepings, dirt, leaves, catch basin dirt and contents of litter receptacles.

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

The Glossary was essentially compiled from: U. S. Department of Health, Education and Welfare, Public Health Service, "Elements of Solid Waste Management", Training Course Manual in Solid Wastes, 1967.