SOLID WASTE MANAGEMENT

IN THE TERRITORY OF GUAM

This report (SW-18ts) was written by

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F O R E W O R D

IN KEEPING WITH the basic purpose of the Solid Waste Disposal Act of 1965, one of the functions of the Bureau of Solid Waste Management is to provide technical assistance to those State, local and private agencies who request help in the planning, development, and implementation of improved solid waste disposal programs. At the request of the Government of Guam, the Bureau conducted a basic data survey to study waste generation, collection practices, and disposal and management methods on the island. The basic data and the study are reported in the following publication (SW-18ts). Our findings and recommendations will hopefully be useful in establishing more efficient, economic methods of solid waste collection and disposal on Guam, where special problems in solid waste management have been created by climate, topography, limited land area, and military installations. The study methods described in the report may be applicable to other areas with similar solid waste management problems.

--RICHARD D. VAUGHAN, *Director*
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SOLID WASTE MANAGEMENT IN THE TERRITORY OF GUAM

Solid waste collection and disposal is a growing problem in the Territory of Guam. Considerable effort has gone into studying the shortcomings of the solid waste system of the Territory, and this effort resulted in a report by Eldon P. Savage in January 1966 and another by Albert E. Bertram in September 1967. Both reports defined problem areas and made recommendations for improving collection and disposal practices. In 1968 the Government of Guam requested assistance from the Bureau of Solid Waste Management through the San Francisco Regional Office of the U.S. Public Health Service for further study of their system. Accordingly, Mr. Donald M. Keagy, Solid Waste Management Representative, Environmental Control Administration, Region IX, and Mr. Jack DeMarco, Deputy Director, Division of Technical Operations, Bureau of Solid Waste Management, went to Guam in August 1968 to confer with local officials on the extent of assistance needed. A report on their visit was submitted to the Government of Guam in November 1968 (Appendix A).

In an effort to assist the Government of Guam in implementing the recommendations of that report, the Division of Technical Operations agreed to conduct a basic data survey on the island. The study took place from February 23 through March 7, 1969, and concentrated primarily on collection practices and waste generation. Attention was also given to management and disposal methods.

The study was directed by Claude A. J. Schleyer, Chief, Systems Section, Technical Assistance and Investigations Branch, Division of Technical Operations, Bureau of Solid Waste Management. Harry R. Little served as project officer and was directly responsible for the development of the study protocol. Ronald A. Perkins was the third member of the study team and has worked up much of the technical data.

The objectives of this report are to define and evaluate existing solid waste management practices and conditions in the Territory of Guam, and to recommend corrections and improvements to the system.

REPORT SUMMARY

A brief summary of the study team's findings appears on these pages.

Solid Waste Generation

Residential. Residential solid waste on Guam was estimated at 178,460 cu yd, or 23,600, tons per year (Table 1). This amount was collected from a civilian area population of 61,283 as of January 1, 1969. The waste that was studied contained 44 percent combustibles and 56 percent noncombustibles by weight, as received.

Commercial. Commercial solid waste was estimated at 11,180 tons per year. This total includes government buildings and clinics.

Hotels and Motels. Using a previously determined factor of 0.6 lb of solid waste per occupant per day, it was estimated that about 100 tons of waste are collected from hotels and motels annually.

Hospital. The solid waste from Guam Memorial Hospital was estimated at 0.9 tons per day, or 330 tons per year.

Schools. School waste was estimated to be 6.48 tons per school day, or 1,170 tons per year. This is based on an observed amount of 0.11 cu ft of solid waste per student per day, and 4.4 lb per cu ft.

Labor Camps. Labor camps are estimated to produce about 1,090 tons of solid waste per year from a population of 1,865.

TABLE 1

SUMMARY OF ESTIMATED AMOUNT OF SOLID WASTE GENERATED

IN CIVILIAN AREAS OF GUAM, BY SECTOR

Sector	Tons/day	Tons/year
Residential	64.7	23,600
Commercial	30.6	11,180
Government*	-	-
Hotel and Motel	0.3	100
Industrial†	-	-
Agricultural†	-	-
Hospital	0.9	330
School	3.2	1,170
Labor camps	3.0	1,090
Total	102.7	37,470

*Included in commercial sector.
†Small amount.

Military. The Navy estimates that their activities generate 650,000 cu yd of solid waste per year, and the Air Force sets their estimate at 390,840 cu yd per year. If a unit weight of 5.6 lb per cu ft is assumed, these amounts become 48,000 and 30,000 tons per year, respectively.

Abandoned Vehicles. There are approximately 2,000 abandoned vehicles on the island that are not located in organized storage areas.

Solid Waste Storage

Eighty percent of the storage containers encountered on Guam were 55-gal drums, 10 percent were 32-gal containers, and the remaining 10 percent were other types. Burning and littered storage areas were common.

The average weight of the storage containers was 65 lb when loaded and 42 lb when empty. Thus, only 23 lb, or 35 percent of the total weight, was actually waste to be collected.

Solid Waste Collection

Collection of solid waste is the responsibility of the Department of Public Works. For this purpose, ten trucks are operated on a day shift and three on an evening shift during the 6-day work week.

Both packer trucks and dump trucks are used. It was found, however, that dump trucks take 238 percent as much time as packer trucks to collect waste from a "typical" mile of residences on Guam.

Solid Waste Disposal

The Government of Guam operates five solid waste disposal sites, all of which are open, burning dumps. There is an operator and a single bulldozer at one dump, but no attempt is made to cover the waste.

RECOMMENDATIONS

The Territory of Guam has a serious solid waste management problem. Major planning and financial effort on the part of the Government of Guam must begin now if progress is to be made. The Territory must establish regular collection of solid waste, provide adequate facilities to dispose of all waste in a sanitary manner, and have the ability to meet emergency needs during periods of large waste production that would follow a typhoon or similar catastrophe.

To achieve the goal of regular collection of solid waste, the following measures are recommended:

1. The Department of Public Works should secure sufficient equipment and manpower to provide twice-weekly collection from all residences and businesses and daily collection from schools, hospitals, government offices, and food preparation establishments.
   a. It is estimated that nine additional packer trucks similar to those already on hand will be needed to provide this service (Appendix G). Back-up equipment will also be needed.
   b. Twelve drivers and 24 collectors will be necessary for the packer trucks.
   c. Salaries should be raised to attract enough qualified workers. Collectors work harder than common laborers and should therefore receive more pay.

d. A training program for new employees and continued training of crews should be instituted to insure safe and efficient operation of the equipment.

e. Candidates for collectors and drivers should be subjected to physical and mental aptitude examinations in keeping with the position for which they are applying.

2. The dump trucks that are presently being used should be retained for the collection of bulky waste and as back-up units for the packers.

3. The Refuse Division should be headed by one person with three supervisors under him who will have direct responsibility for the crews.

4. Night shift operations should be eliminated. With the present level of training and the lack of supervision, operation of packer trucks at night results in unnecessary exposure of workers to accidents.

5. A third collector should be placed on the dump trucks as an interim measure until new equipment is purchased. The driver could then remain in the cab at stops and speed up collection.

6. The statutes prohibiting on-site, open burning of solid waste should be enforced.

7. The size and weight of storage containers should be specified and enforced.

8. Yard and bulky waste should be bundled for collection. Bundles should be less than 5 ft long and weigh under 75 lb.

9. Solid waste storage containers should be kept at the rear of the residences rather than at the curb. Homeowners should carry out their waste on the day of collection and return their empty containers. This arrangement will require the establishment of set routes that will be collected on specific days.

10. The possibility of using liners in storage containers should be investigated since they would allow additional storage capacity and would make curbside carryout easier.

11. The possibility of using bulk containers at schools, hospitals, offices, and other large waste producers should be investigated. Two of the present trucks are capable of handling bulk containers.

12. A system of tagging unsafe or unlawful containers should be instituted. Collectors could mark such containers and indicate that they will no longer collect them.

Improved collection will result in greater amounts of solid waste that must be disposed of in a safe and sanitary manner. It is therefore recommended that:

1. the five open-burning dumps be closed, with due regard for insect and rodent control;

2. a single sanitary landfill be established;

3. the Ordot dump, Agana swamp, and several abandoned quarry pits be included in the engineering investigations that will be necessary to select the best site.

Improvements can also be made in administrative practices. A cost-accounting and control system applicable to efficient solid waste management should be instituted. The first steps should include keeping daily records on the production of each collection crew and on the amounts of waste received at the landfill. The latter should be done on a weight received basis, but it could also be done on a volume basis.

Present legislation (Appendix H) is in need of major revision. Special attention is needed in the following sections:

§9660. Definitions should be expanded and updated in accordance with present terminology.

§9660.2. Reference to metal containers should be omitted and capacity limited to 20 to 32 gal with an empty weight of less than 20 lb.

§9660.3. Rubbish should be required to be placed in approved containers with tight-fitting lids. Large items such as tree limbs, weeds, etc. should be securely tied in bundles not to exceed 60 in. in length or 75 lb in weight.

§9660.6. Garbage, rubbish, and other offensive substances should be limited to disposal in a sanitary landfill. Placing solid waste in or near water sources should be prohibited.

§9660.7. This section should end after the word "substances" in line five, so that all burning of garbage, dead animals, or other offensive substances (except in an approved incinerator) would be prohibited.

§9660.12, §9660.13, §9660.14, and §9660.16. These sections should be revised in accordance with disposal in a sanitary landfill.

A section should be added to provide penalties for the violation of the provisions of this act.

To enlist the cooperation of the people of Guam, certain steps should be taken, including the establishment of a public relations program to make people aware of the problems and of the Government's efforts to resolve them.

The Government of Guam collects and disposes of less than a third of the solid waste collected on the island. Navy and Air Force authorities are faced with a large responsibility in this area that is not in keeping with their primary mission. It is therefore possible that they would relinquish their activities in solid waste management to a competent local authority. In this light, it is recommended that the Government investigate the possibility of combined, island-wide collection and disposal and the possibility of using existing military solid waste disposal sites.

In keeping with the above recommendations, it is further recommended that the Territory of Guam develop a comprehensive solid waste management plan that will extend through the year 2000.

GENERAL DESCRIPTION OF GUAM

Guam is the southernmost island in the Marianas chain and is a territory of the United States (Figure 1). It is governed by a presidentially appointed governor and guided by a group of 21 elected senators. Each of the 19 districts elects a commissioner, and although he has no official powers, he usually exercises a great deal of influence over the people of the district.

The island of Guam has an area of about 212 square miles (Figure 2). It is 30 miles long, and varies from a width of $8\frac{1}{2}$ miles in the northern part, to 4 miles at the central part, to $11\frac{1}{2}$ miles in the southern part.

Most of the following information on the topography, geology, climate, population, and development of Guam has been quoted directly from a geological survey paper published by the U.S. Department of the Interior.[1]

Topography

> The northern half of Guam is a gently undulating limestone plateau bordered by steep wave-cut cliffs. The plateau slopes generally south-westward from altitudes of approximately 600 feet in the north to less than 100 feet at the narrow midsection of the island. The generally uniform surface is interrupted by three hills -- Barrigada Hill (665 ft), which is a broad limestone dome, and Mount Santa Rosa (858 ft) and Mataguac Hill (630 ft), which are composed of volcanic rock.
>
> No perennial streams exist on the plateau because of the high permeability of the limestone. Water may flow in short channels in the limestone during heavy rains, but it soon disappears into numerous sink holes and fissures. Local runoff has eroded gullies in the volcanic rock of Mount Santa Rosa and Mataguac Hill, but here also the water sinks rapidly into the limestone that surrounds the hills.

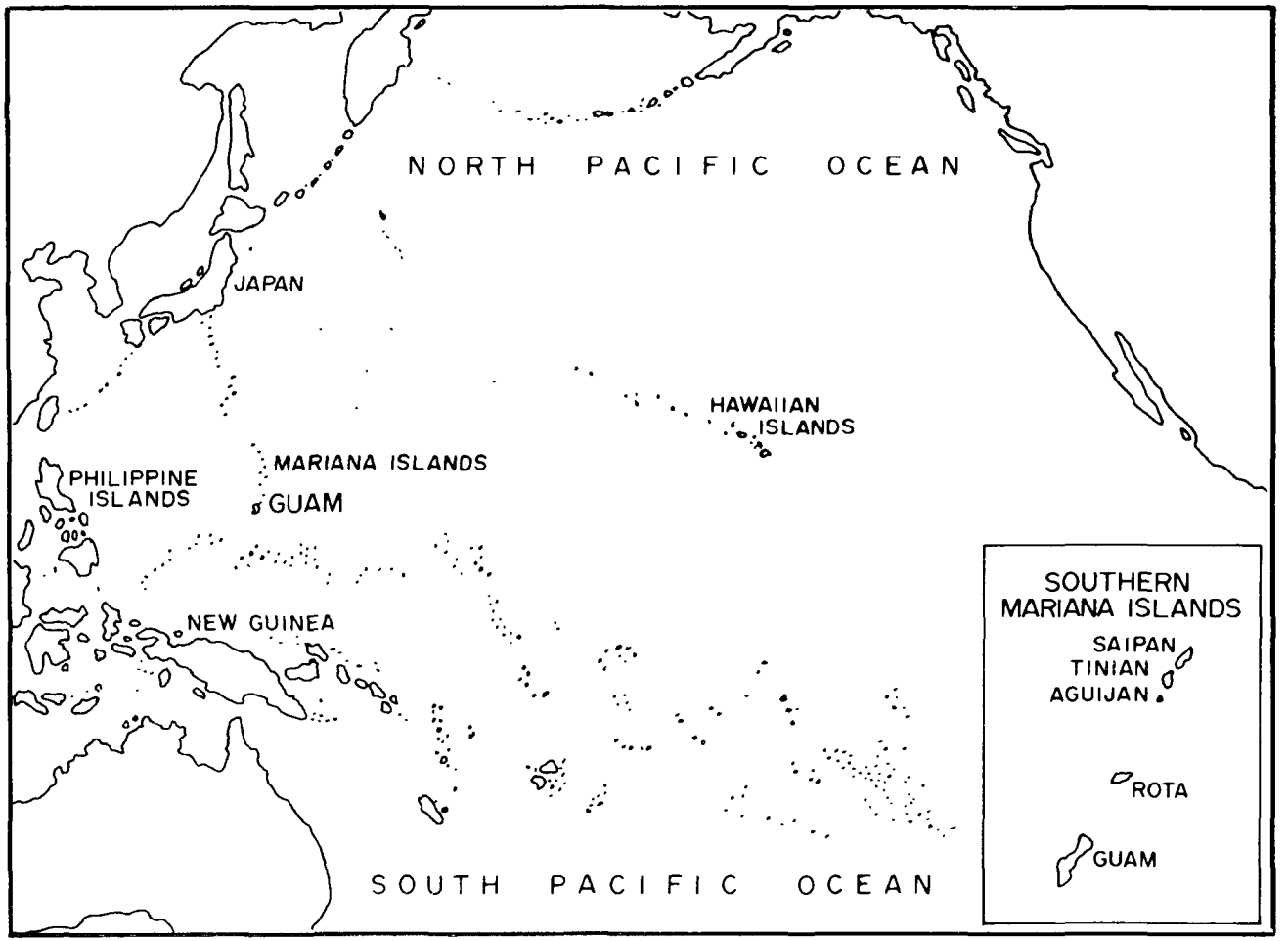

Figure 1. Location of Guam. (Source: Ward, P.E., S.H. Hoffard, and D.A. Davis. Hydrology of Guam. Geological Survey Professional Paper 403-H. Washington, U.S. Government Printing Office, 1965. 28 p.)

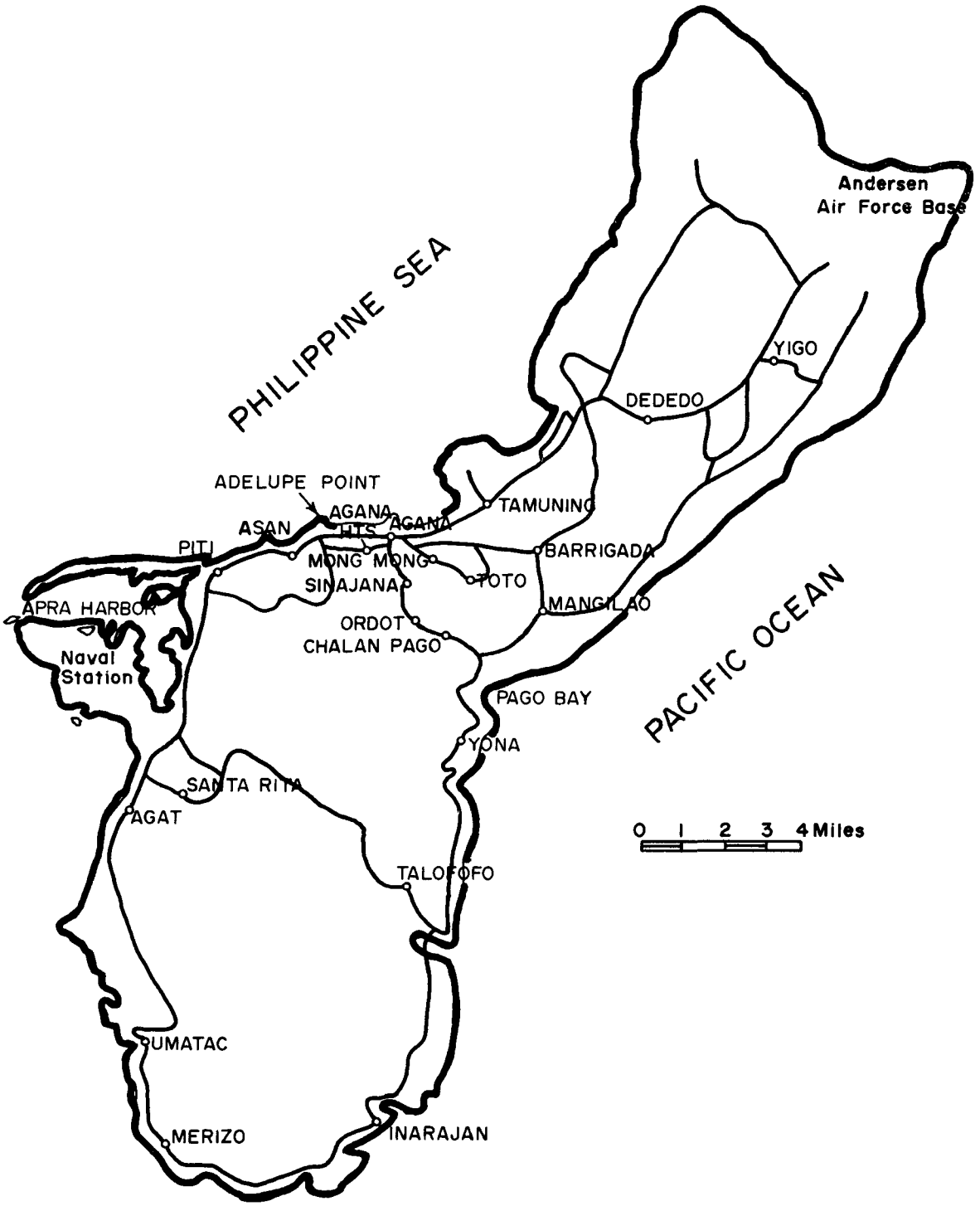

Figure 2. Territory of Guam.

It would therefore not be advisable to locate sanitary landfills in the northern part of the island unless adequate precautions were taken to prevent drainage from the fill into the porous limestone. It is expected, then, that any landfill would be located in the southern portion of the island, which is primarily volcanic in origin.

Geology

The principal rock in the plateau in northern Guam is the Barrigada Limestone, which lies unconformably on an irregular surface eroded in volcanic rock of the Alutom Formation and is overlain by a veneer of the Mariana Limestone. The base of the Barrigada under most of the plateau is below sea level. The volcanic rock extends above sea level in an area of several square miles near the northern end of the island and projects through the limestone at Mount Santa Rosa and Mataguac Hill. Most of the limestone in the plateau contains numerous caverns, fissures, and other solution openings, which give the rock a high overall permeability. The volcanic rock has low permeability.

The rocks south of a line between Pago Bay and Adelupe Point consists mainly of a complex of pyroclastic rock and lava flows, clastic sediments derived from the volcanic rock, and small amounts of interbedded limestone, which make up the Alutom, Umatac, and Bonya Formations. Overlying parts of the complex are beds of the Alifan Limestone forming caps on peaks and ridges, and the Mariana Limestone forms marginal aprons along the coast.

The volcanic rock and clastic sediments are thoroughly weathered to depths of 50 feet or more over much of the area of exposure. The upper few feet of the weathered section is commonly granular and friable. The permeability of the fresh and weathered rock is low; the friable mantle is generally a little more premeable than the underlying material. The limestone lying on the volcanic and clastic rock has high permeability.

Climate

Guam is warm and humid. The mean annual temperature near sea level is about 81°F; monthly means range from about 80° in January to 82½° in June, and recorded extremes range from 64° in February to 100° also in February. The relative humidity is rarely less than

60 percent, and the mean humidity ranges from 66 percent in the early afternoon to 89 percent in the early morning. [Additional temperature data have been compiled by the U.S. Department of Commerce (Table 2.)]

Easterly trade winds are dominant throughout the year, and they blow 90 percent of the time from January through May. Calms are rare from January through May and are frequent from June to October. Tradewind speeds generally are between 4 and 12 mph (miles per hour) and rarely exceed 24 mph, but typhoons passing over or near the island may bring winds having speeds greater than 100 mph.

Guam has two distinct seasons--a dry season from January through May and a wet season from July through November. December and June are transitional, or from year to year they may fall in either the wet season or dry season. The mean annual rainfall ranges from about 80 inches on the coastal lowlands in the Apra Harbor area to about 100 inches on the uplands in southern Guam. Of the total rainfall, 15-20 percent falls during the dry season, 68-73 percent during the wet season, and the remainder during the two transitional months. Dry-season rainfall is mostly from scattered light showers [Table 3]. During the wet season, about a third of the rainy days have prolonged and steady rain.

The heaviest prolonged rainfall on Guam is during the passing of typhoons. The greatest rainfall recorded during a 24-hour period in postwar years occurred during typhoon Alice on October 14-15, 1953, when 24.90 inches fell at Andersen Air Force Base and 15.80 inches at the Agana Naval Air Station. The median of the rainfall at 12 widely scattered stations during the 5-day period of rainfall associated with the typhoon was about 24 inches.

Population and Development

The population of Guam, including the military forces, was about 67,000 in 1960 according to the reports of the U.S. Bureau of the Census. The civilian population is concentrated in towns and villages in the central part of the island and in villages scattered along the southern coast. Centers of military population are at the Andersen Air Force Base in the northern part of the island, the Agana Naval Air Station, near Agana, and at Guam Naval Base, at Apra Harbor.

TABLE 2

REPORTED TEMPERATURES ON GUAM

Period	Temperature						
	Normal			Extremes			
	Daily maximum	Daily minimum	Monthly average	Record high	Year	Record low	Year
January	83.9	72.4	78.2	87	1962	60	1962
February	84.4	72.2	78.3	88	1960	59	1959
March	85.3	72.2	78.8	89	1965	54	1965
April	86.4	73.3	79.9	90	1960	59	1965
May	87.1	73.6	80.4	90	1966	62	1960
June	87.3	73.1	80.2	91	1959	65	1965
July	86.7	72.3	79.5	93	1966	66	1959
August	86.4	72.2	79.3	91	1966	68	1965
September	86.2	72.3	79.3	95	1957	61	1958
October	85.8	72.7	79.3	91	1957	66	1965
November	85.2	73.3	79.3	89	1962	62	1957
December	84.4	73.0	78.7	89	1966	61	1967
Year	85.8	72.7	79.3	95	1957	54	1965

Source: Local climatological data; annual summary with comparative data, 1967, Guam, Pacific. U.S. Department of Commerce [1968]. 4 p.

TABLE 3

SUMMARY OF RAINFALL AT AGANA NAVAL AIR STATION, GUAM, 1952-62
(Inches)

Month	Average	Maximum	Minimum	Median
January	3.83	8.07	13.40	2.53
February	2.73	9.53	0.31	2.10
March	1.90	4.08	0.58	1.78
April	2.87	7.35	0.66	2.45
May	3.68	6.09	0.66	2.91
June	4.48	9.38	1.20	4.48
July	9.10	18.03	4.74	7.47
August	12.68	23.49	7.37	11.58
September	14.71	18.93	9.82	15.14
October	13.06	26.48	9.36	11.29
November	10.18	13.75	6.78	10.32
December	5.46	8.25	2.14	5.14
Annual	84.70	112.76	63.57	84.71

Source: Ward, P.E., S.H. Hoffard, and D.A. Davis. Hydrology of Guam. Geological Survey Professional Paper 403-H. Washington, U.S. Government Printing Office, 1965. 28 p.

Most of the civilian population is supported directly or indirectly by the activities of the Armed Forces. About 40 percent of the civilian labor force is employed by the Territorial and Federal governments. The remaining force is engaged largely in construction, trade, transportation, and other services. About 5 percent work in manufacturing and agriculture.

Agana is the center of civil government and of much of the commercial activity of the island. Commercial ships dock at Apra Harbor, and commercial airlines land at the Naval Air Station. A hard-surface road system covers the northern and central parts of the island. Light-surface roads run along the east coast from Pago Bay around the southern end to Umatac and along the west coast from Agat almost to Umatac.

Guam is currently undergoing rapid economic growth. New construction is evident everywhere, and construction of several new hotels to accommodate the developing tourist trade has begun. Pan American Airlines and Air Micronesia (Continental Air Lines) are presently serving the area. Trans World Airlines has been awarded a transpacific route to Guam that should further stimulate the tourist industry, and several shipping lines have begun stopovers in Guam that will very likely increase as the new commercial port is completed.

Because of the economic boom, there is difficulty in obtaining qualified individuals to fill vacant jobs. The problem is evident in the various departments of the Government of Guam, where many positions have not been filled for months or years after their creation.

Most of the island's population is concentrated in the central area. There are 19 villages, ranging in size from 982 to 6,748 inhabitants (Table 4). The total civilian area population is now estimated at 61,283 by the Department of Public Works.

TABLE 4

POPULATION OF GUAM

(Civilian areas only)

Village	January 1, 1969*	April 1, 1968†	April 1, 1967
Agana	2,419	2,356	2,200
Agana Heights	3,729	3,612	3,328
Agat	4,904	4,737	4,260
Asan	2,545	2,450	2,307
Barrigada	5,431	5,240	2,307
Chalan Pago-Ordot	2,340	2,233	2,058
Dededo	5,749	5,332	4,240
Inarajan	2,253	2,183	2,098
Mangilao	3,518	3,417	2,968
Merizo	1,852	1,807	1,732
Mongmong-Toto-Maite	2,604	2,469	2,420
Piti	1,322	1,252	1,188
Santa Rita	2,525	2,440	2,333
Sinajana	5,283	5,159	4,813
Talofofo	1,840	1,779	1,739
Tamuning	6,748	6,320	5,508
Umatac	982	912	882
Yigo	2,150	1,929	1,685
Yona	3,089	2,971	2,919
Total	61,283	58,598	53,744

*Data from Department of Public Works, Guam.
†Data from Department of Health and Social Services, Guam.

STUDY PROCEDURE

Before the arrival of the study team on Guam, personnel of the Department of Public Works collected information on the number of dwelling units, schools, businesses, government buildings, industries, hotels, and labor camps on the island. Included was information on village populations, school enrollments, and capacities of the labor camps. These data were used in the preparation of this report.

The study team also gathered data on the amount of solid waste collected by the Government of Guam. Volumes of solid waste were estimated by accompanying a collection truck and recording the volume of waste collected at each service. The total number of items, which was defined as the number of containers, bundles, or other objects collected, was also recorded for each service. The team collected data on 7 days for a total of 683 services in six villages. Residences, schools, businesses, and parks were included.

To determine the density of the waste in the storage containers (Appendix B), 110 items for collection were weighed with a platform balance carried on a pickup truck. Such weights were recorded for residential waste in two of the villages. To check the reliability of the individual weighings, loaded collection vehicles were weighed on a commercial scale.

Collected residential waste was separated in order to predict the impact of changing present methods of waste preparation and storage

by residents. Waste samples of approximately 200 lb were hand separated into nine components (Appendix C) and subjected to moisture content determinations so that the amount of water in the solid waste could be calculated.

Time studies of collection crews at work were done to formulate predictive equations of collection times for packer trucks and dump trucks (Appendix F).

Surveys of solid waste storage practices and abandoned vehicles were also conducted. Actual counts of abandoned vehicles and storage containers were made in nine of the 19 villages on the island.

The study team visited and inspected possible future sanitary landfill sites with government officials in an effort to evaluate their availability and acceptability. United States Navy and Air Force installations were also visited to determine their methods of solid waste management and to evaluate the feasibility of their possible adoption by the Government of Guam.

RESULTS AND DISCUSSION

Solid Waste Generation

Residential. According to information obtained from the Department of Public Works, there are a total of 12,693 residential dwelling units on the island of Guam (Table 5). During the period of the study, the average amount of residential solid waste collected was found to be 7.30 cu ft per dwelling per week and the average number of items collected was 1.82 (Table 6).

Analysis of the 110 weighings indicated that the average density of the residential waste was 4.9 lb per cu ft (standard deviation of 0.33). Data obtained from the weighing of loaded trucks gave densities under storage conditions of 5.8 and 4.9 lb per cu ft. The similarity of these three figures increases confidence in the use of 4.9 lb per cu ft.

Moisture content determinations on the residential solid waste samples (Appendix D) showed an average moisture content of 15.4 percent on a wet-weight basis. Since the study took place during the dry season, it is felt that both the moisture content and the weight of the waste will increase during periods of heavy rain because of the use of open storage containers.

An analysis of the effect of rainfall on the moisture content of solid waste (Appendix E) develops a relationship between weekly rainfall

TABLE 5

DISTRIBUTION OF RESIDENTIAL DWELLING UNITS

ON GUAM, MARCH 1, 1969

Village	Single-family units	Multiple-family units	Total
Agana	170	148	318
Agana Heights	590	81	671
Agat	720	101	821
Asan	365	76	441
Barrigada	969	107	1,076
Chalan Pago-Ordot	450	13	463
Dededo	1,372	49	1,421
Inarajan	300	38	338
Mangilao	675	112	787
Merizo	294	2	296
Mongmong-Toto-Maite	585	98	683
Piti	223	34	257
Santa Rita	440	29	469
Sinajana	686	69	755
Talofofo	334	36	370
Tamuning	1,829	304	2,133
Umatac	117	0	117
Yigo	562	14	576
Yona	679	22	701
Total	11,360	1,333	12,693

Source: Department of Public Works, Guam.

TABLE 6

COLLECTED RESIDENTIAL SOLID WASTE

(Weekly collection)

Route and date collected	Items/dwelling		Vol/dwelling (cu ft)		Vol/item (cu ft)	
	Mean	Standard deviation of the population	Mean	Standard deviation of the population	Mean	Standard deviation of the population
Tamuning (2-25-69)	1.65	0.75	6.22	3.84	3.76	.26
Mangilao (2-26-69)	1.59	0.94	6.11	4.49	3.84	.26
Tamuning (2-27-69)	2.18	1.91	8.41	7.39	3.85	.31
Yigo (2-28-69)	2.07	1.39	9.15	4.55	4.41	.30
Merizo (3-3-69)	1.44	1.01	5.86	4.17	4.08	.30
Dededo (3-5-69)	1.92	1.42	7.76	6.32	4.04	.27
Asan (3-6-69)	1.92	1.68	9.64	8.27	5.02	.86
Average	1.82	1.36	7.30	5.77	4.02	.12

and the unit weight of the residential solid waste. The results of this analysis give an average annual unit weight of 9.8 lb per cu ft. The density would change with the season, as mentioned; but for the purposes of this report, it is felt that the average density of 9.8 lb/cu ft is a conservative estimate and will give acceptable results.

Use of this average density and the data presented in Table 6 allows the calculation of the total tons of solid waste collected each year from residences (Table 7).

Residential solid waste amounts to an estimated 178,460 cu yd, or 23,600 tons per year (Table 7). Using a civilian area population of 61,283, this amount becomes 2.1 lb of residential solid waste per capita per day, or about 770 lb per capita per year.

During the period of the study, five separations of residential solid waste were made to determine composition. Samples were hand separated into nine categories (Appendix C), and the results are shown in Table 8.

Similar separations of residential solid waste have been made in the continental United States (Table 9).[2] A recently completed national survey of solid waste in the continental United States[3] estimates that a daily average of 3 lb of residential solid waste per capita is collected.

The daily per capita amount of each waste component is then found by multiplying the total average per capita (3 lb) by the average percent of each component by weight (Table 9). A similar analysis was

TABLE 7

ESTIMATED VOLUME AND WEIGHT OF RESIDENTIAL SOLID WASTE COLLECTED

Village	Total dwelling units*	Cubic yards per year†	Tons per year‡
Agana	318	4,470	590
Agana Heights	671	9,430	1,250
Agat	821	11,540	1,530
Asan	441	6,200	820
Barrigada	1,076	15,130	2,000
Chalan Pago-Ordot	463	6,510	860
Dededo	1,421	19,980	2,640
Inarajan	338	4,750	630
Mangilao	787	11,070	1,460
Merizo	296	4,160	550
Mongmong-Toto-Maite	683	9,600	1,270
Piti	257	3,610	480
Santa Rita	469	6,590	870
Sinajana	755	10,620	1,400
Talofofo	370	5,200	690
Tamuning	2,133	29,990	3,970
Umatac	117	1,650	220
Yigo	576	8,100	1,070
Yona	701	9,860	1,300
Total	12,693	178,460	23,600

*From Table IV.
†(No. of Dwellings)x(7.3)x(52)÷(27).
‡(Cubic Yards per Year)x(27)x(9.8)÷(2000).

TABLE 8

COMPOSITION OF RESIDENTIAL SOLID WASTE IN GUAM, FEBRUARY 26, 1969, to MARCH 5, 1969

Village and date of collection	Component (percent by weight)									Sample weight (lb)	Moisture content (%)
	Food waste	Garden waste	Paper products	Plastics, rubber, leather	Textiles	Wood	Metals	Glass and ceramics	Rocks, dirt, ashes, etc.		
Mangilao (2-26-69)	2.0	10.0	15.8	2.6	1.5	1.3	47.3	11.4	8.1	227.5	8.9
Yigo (2-28-69)	9.4	3.3	17.4	0.8	2.5	2.8	38.5	16.4	8.9	180.5	11.5
Merizo (3-3-69)	2.2	12.4	15.3	3.4	4.5	0.7	37.5	18.0	6.0	133.5	--
Tamuning (3-4-69)	14.0	17.4	17.0	2.7	9.5	1.3	21.2	11.0	5.9	264.0	24.2
Dededo (3-5-69)	10.3	11.1	14.9	1.3	7.3	3.5	31.0	11.8	8.8	198.5	16.9
Average	7.7	10.7	16.0	2.2	5.1	1.9	35.3	13.6	7.5	199.0	15.4

TABLE 9

COMPOSITION OF RESIDENTIAL SOLID WASTE IN GUAM AND THE CONTINENTAL UNITED STATES

Component	Average percent of component by weight		Estimated pounds of component per capita per day†	
	Guam	Continental United States*	Guam	Continental United States
Food waste	7.7	22	0.16	0.66
Garden waste	10.7	5	0.22	0.15
Paper products	16.0	48	0.34	1.44
Plastic, rubber, leather	2.2	3	0.05	0.09
Textiles	5.1	2	0.11	0.06
Wood	1.9	1	0.04	0.03
Metals	35.3	8	0.74	0.24
Glass and ceramics	13.6	7	0.28	0.21
Rocks, dirt, ashes, etc.	7.5	4	0.16	0.12
Total	100.0	100	2.10	3.00

*From unpublished data, U.S. Public Health Service, Bureau of Solid Waste Management, Division of Technical Operations.

†Based on 3.0 lb of residential solid waste per capita per day for the Continental United States and 2.1 lb per capita per day for Guam.

made for Guam based on the average percentages given in Table 8 and a per-capita waste amount of 2.1 lb per day (Table 9).

By comparing the percentage compositions of waste for the continental United States and Guam (Table 9) it is seen that Guam has higher percentages of garden waste and noncombustibles than the continent, and lower percentages of food waste and paper products. A comparison of the per-capita amount of each waste component collected points out further differences between Guam and the continental United States.

The present practice of feeding food waste to poultry and swine is probably responsible for removing large amounts of this component from the collected residential waste. If this practice were stopped, the amount of food waste collected would increase and perhaps would reach those levels estimated for the continental United States.

Burning of combustibles by private individuals is partially responsible for the low quantities of paper products collected. If such household burning of waste were eliminated, the amount of paper waste collected would of course increase. It would not be expected to reach the quantities encountered on the mainland, however, because of the extensive use of metal packaging materials and the high local cost of paper convenience items such as plates, tablecloths, and other similar items.

If the household burning of combustibles and the feeding of food waste to poultry and swine were stopped in the near future, the amounts

of paper products and food waste collected daily could be expected to increase by about 0.7 and 0.5 lb per capita, respectively. This increase would result in an estimated 3.3 lb of residential waste collected daily per capita.

Commercial. The waste-generation rate for commercial activities is usually related to gross sales, number of employees, floor area, or some other similar measurement. Accurate information of this type could not be obtained by the study team in the time permitted. Areas of commercial operations were identified, however, throughout the island (Table 10). It was beyond the magnitude of this study to categorize each activity, but it was observed that most commercial establishments were either grocery stores, laundries, electronics shops, or other similar types of small businesses characteristic of any community. Most of the commercial waste is generated in those areas with the highest concentration of such activities, primarily in the villages of Agana and Tamuning and the adjacent areas.

Previous studies of commercial waste in the continental United States have defined an average amount of waste collected as about 1 lb per person daily.[3] Using this figure as a base, a reasonable estimate of the amount of commercial waste collected is about 30.6 tons per day, or 11,180 tons per year.

The unit weight would be about 150 lb per cu yd or 5.6 lb per cu ft.[4] This would mean that commercial wastes would amount to about 149,000 cu yd per year.

TABLE 10

DISTRIBUTION OF COMMERCIAL AND GOVERNMENT ACTIVITIES IN GUAM

Village	Number of commercial establishments*	Number of government buildings*
Agana	149	8
Agana Heights	16	1
Agat	36	3
Asan	17	3
Barrigada	42	1
Chalan Pago-Ordot	8	1
Dededo	21	1
Inarajan	11	3
Mangilao	10	4
Merizo	13	2
Mongmong-Toto-Maite	34	1
Piti	10	2
Santa Rita	5	1
Sinajana	32	2
Talofofo	10	1
Tamuning	104	3
Umatac	6	1
Yigo	11	1
Yona	12	1
Total	547	40

*Data from Department of Public Works, March 1, 1969.

Government. Government buildings on Guam were also tabulated by the study team (Table 10). The amount of waste generated by government office activities is small and is assumed to be included in the figures for commercial wastes.

Hotels and Motels. The number of hotel and motel rooms on Guam total 445 (Table 11). Past studies[5] have indicated that the amount of waste generated by hotels and motels is about 0.6 lb per occupant daily. If it is assumed that two people occupy each room, there will be an estimated 100 tons of waste generated per year from these sources.

Composition of waste from hotels and motels would be expected to be about 80 percent combustibles (including 5 percent food waste), and 20 percent noncombustibles.

Parks. Parks were not studied directly in this survey. The amount of waste generated in the parks on Guam is small in relation to other sources, and their omission here is not serious. Studies in other areas, however, have shown that a picnicker can be expected to generate about 1 lb of waste per meal.[5]

Composition of park waste in the continental United States is about 45 percent food waste, 30 percent other combustibles, and 25 percent noncombustibles.[5] The composition is expected to be somewhat different on Guam because of packaging methods--about 40 percent food waste, 25 percent other combustibles, and 35 percent noncombustibles.

Industrial. Industrial activity in the civilian areas on Guam is very light. Therefore, no estimation of industrial waste was made.

TABLE 11

ESTIMATED AMOUNTS OF SOLID WASTE GENERATED ANNUALLY

BY HOTELS AND MOTELS ON GUAM

Village	Number of rooms*	Tons of waste per year†
Agana	33	7
Agana Heights	249	55
Agat	0	0
Asan	0	0
Barrigada	0	0
Chalan Pago-Ordot	0	0
Dededo	0	0
Inarajan	0	0
Mangilao	0	0
Merizo	9	2
Mongmong-Toto-Maite	101	22
Piti	0	0
Santa Rita	0	0
Sinajana	0	0
Talofofo	0	0
Tamuning	62	14
Umatac	0	0
Yigo	0	0
Yona	0	0
Total	445	100

*Data from Department of Public Works, March 1, 1969.
†(No. of Rooms) × (2) × (0.65) × (365) ÷ (2000).

Agricultural. There is very little agriculture on Guam. For this reason, the contribution of agriculture to the solid waste problem is small and is not considered in this report.

Hospitals and Clinics. Guam has one civilian hospital and 27 clinics of various sizes. Most of the clinics are offices, and their wastes are assumed to be included in the total amount of commercial waste.

Hospital solid waste is estimated at 7 to $8\frac{1}{2}$ lb, or 0.7 cu ft per patient daily.[6] Guam Memorial Hospital treats about 235 patients per day. Therefore, using a figure of 7.7 lb per patient per day, the annual contribution of the hospital would be approximately 330 tons, or 2,200 cu yd of solid waste per year.

Schools. The Government of Guam operates junior and senior high schools, elementary schools, head start projects, and the University of Guam. The Catholic Church is also quite active in education and operates both elementary and high schools. There are also several other parochial schools, private schools, and academies.

Data gathered during the period of the study in a similar manner as for residential waste indicate that each student generates an average of 0.11 cu ft of solid waste per school day (Table 12). The amount of school waste collected by village has been estimated by assuming a density of 4.4 lb per cu ft (Table 13). School waste totals about 1,170 tons per year and is generated primarily during the 9 months from September through May. The school waste was composed mostly of paper

TABLE 12

NUMBER AND VOLUME OF SOLID WASTE SAMPLES FROM SELECTED SCHOOLS ON GUAM, FEBRUARY 25 TO MARCH 7, 1969

School	Number of items collected daily	Volume (cu ft)	Number of students*
Brodie School	7	33	120
Brodie School	6	24	120
St. Francis	20	74	702
7th Day Adventists	2	2	103
Talofofo	2	3	40
Talofofo Public	8	51	364
Notre Dame School	3	19	105
Inarajan Junior and Elementary	28	108	948
Merizo	3	15	98
Merizo Elementary	14	30	297
Adelup School	8	60	701
Old Piti	5	30	385
New Piti	12	57	545
Piti Head Start	2	9	39
Total	120	515	4,567

*Data from Department of Public Works, March 1, 1969.

TABLE 13

ESTIMATED WEIGHT OF SOLID WASTE GENERATED

BY ALL SCHOOLS ON GUAM

Village	Total Number of students*	Estimated tons of waste per day†	Estimated tons of waste per year‡
Agana	902	0.22	39
Agana Heights	506	0.12	22
Agat	2,606	0.63	114
Asan	758	0.18	33
Barrigada	2,744	0.66	120
Chalan Pago-Ordot	1,327	0.32	58
Dededo	3,841	0.93	168
Inarajan	948	0.23	41
Mangilao	3,277	0.79	143
Merizo	395	0.10	17
Mongmong-Toto-Maite	58	0.01	3
Piti	969	0.23	42
Santa Rita	379	0.09	17
Sinajana	1,193	0.29	52
Talofofo	612	0.15	27
Tamuning	3,032	0.73	133
Umatac	147	0.04	6
Yigo	2,172	0.53	95
Yona	913	0.22	40
Total	26,779	6.48	1,170

*From Department of Public Works.
†(No. of Students)×(0.11)×(4.4)×(180)÷(2000).
‡Calendar year (based on 180 school days per year).

and food wastes, with noncombustibles making up only a small portion of the total. Because of its composition, the density used was a little less than that for commercial waste.

Labor Camps. A number of labor camps are operated by construction companies and other contractors to house imported Philippine workers. These camps normally consist of barracks for the workers and associated kitchen, dining, and recreational areas. Information gathered on Job Corps Camps in the United States indicates that about 2.5 lb of kitchen waste and 0.7 lb of waste from the dormitories are generated by each corpsman daily.[5] This total of 3.2 lb of waste per corpsman per day should be valid for estimating waste loads from labor camps. By using the 3.2-lb-per-capita figure, it is estimated that 1,090 tons of waste per year will be generated in labor camps (Table 14).

The composition of the kitchen waste is mostly food scraps, wet paper, and noncombustibles. Dormitory waste is mainly paper by volume but noncombustibles by weight.

Abandoned Automobiles. A survey of abandoned vehicles was made in different areas of the island. Organized junk or car lots were excluded from the survey. Along the 32.5 miles of main arteries surveyed there were found to be 6.3 abandoned vehicles per mile. On the 12 miles of residential streets studied, this ratio was 15.1 vehicles per mile. The total average was 10.7 vehicles per mile.

There are over 200 miles of road on the island of Guam. Using the average figure of 10.7 vehicles per mile, it is estimated that there

TABLE 14

AMOUNT OF SOLID WASTE GENERATED BY LABOR CAMPS ON GUAM

Labor camp	Number of workers*	Estimated tons of waste per year†
Agana	73	43
Agana Heights	140	82
Agat	0	0
Anigva	108	63
Asan	10	6
Barrigada	50	29
Chalan Pago-Ordot	7	4
Dededo	35	20
Harmon	46	27
Harmon Field	81	47
Inarajan	0	0
Mangilao	50	29
Merizo	0	0
Mongmong-Toto-Maite	98	57
Piti	0	0
Santa Rita	0	0
Sinajana	22	13
Talofofo	28	16
Tamuning	1,117	653
Umatac	0	0
Yigo	0	0
Yona	0	0
Total	1,865	1,090

*Data from Department of Public Works, March 1, 1969.
†(No. of Workers) × (3.2) × (365) ÷ (2000).

are approximately 2,000 abandoned vehicles on the island that should be collected and disposed of by the Government of Guam. An effort should be made to find a market for these abandoned vehicles as scrap steel. If they are found to have no salvage value they could be disposed of at sea as has been the practice in the past.

Solid Waste Storage

Residential. As part of the total study, a survey was made of residential solid waste storage practices in nine of the 19 villages on Guam. Included were 384 homes, or 3 percent of the civilian dwelling units on Guam.

Of those residences surveyed, 79 percent stored solid waste in 55-gal drums only, 3 percent used nothing but 32-gal containers, 3 percent used only some other type of containers, and 15 percent used a combination of different types of containers (Figure 3). In addition, 9 percent of the residences had some wastes that were not stored in any type of container (Figures 4 and 5).

The homes that used only 55-gal drums exhibited the following distribution: 58 percent had only one drum, 36 percent had two drums, 5 percent had three drums, and 1 percent had four or more drums (Figure 6).

The 13 homes in the sample using only 32-gal containers showed the following distribution: 46 percent had only one can, 15 percent had two cans, 23 percent had three cans, and 16 percent had four or more cans (Figure 7).

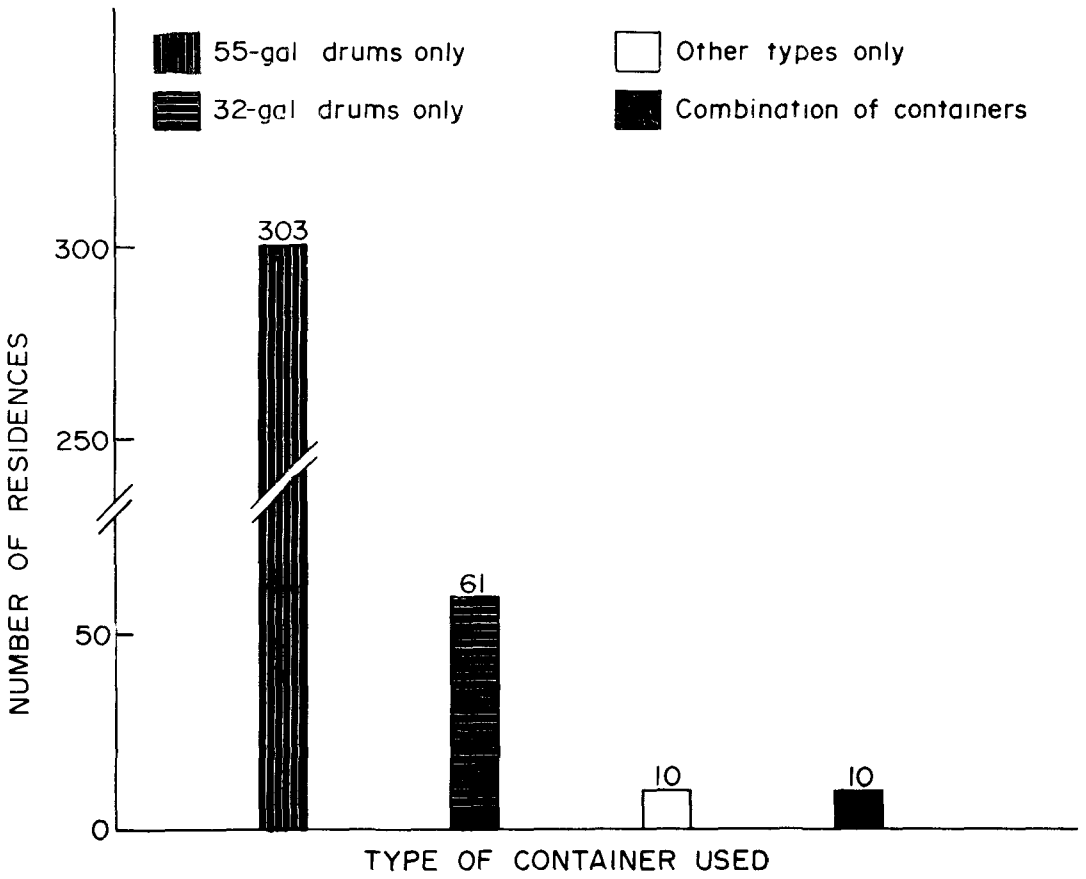

Figure 3. Distribution of residences on Guam, by type of waste-storage container.

Figure 4. Solid waste ready for collection.

Figure 5. Solid waste storage area before collection.

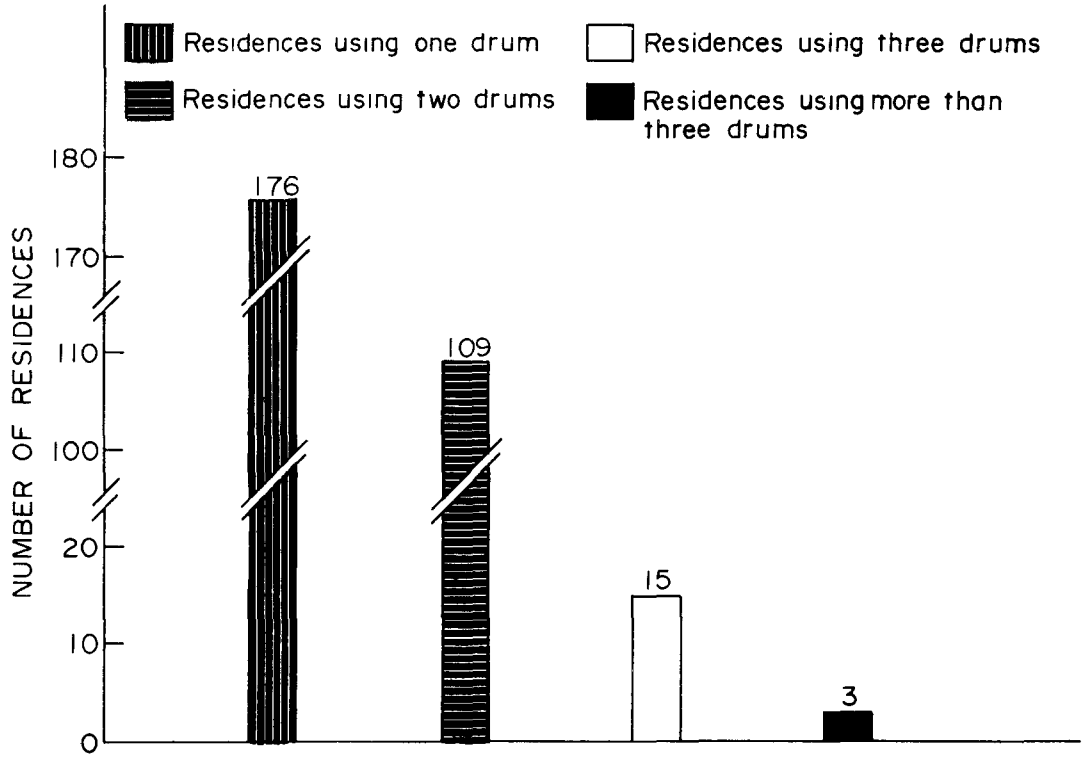

Figure 6. Distribution of residences on Guam using 55-gal waste-storage drums, by number of drums.

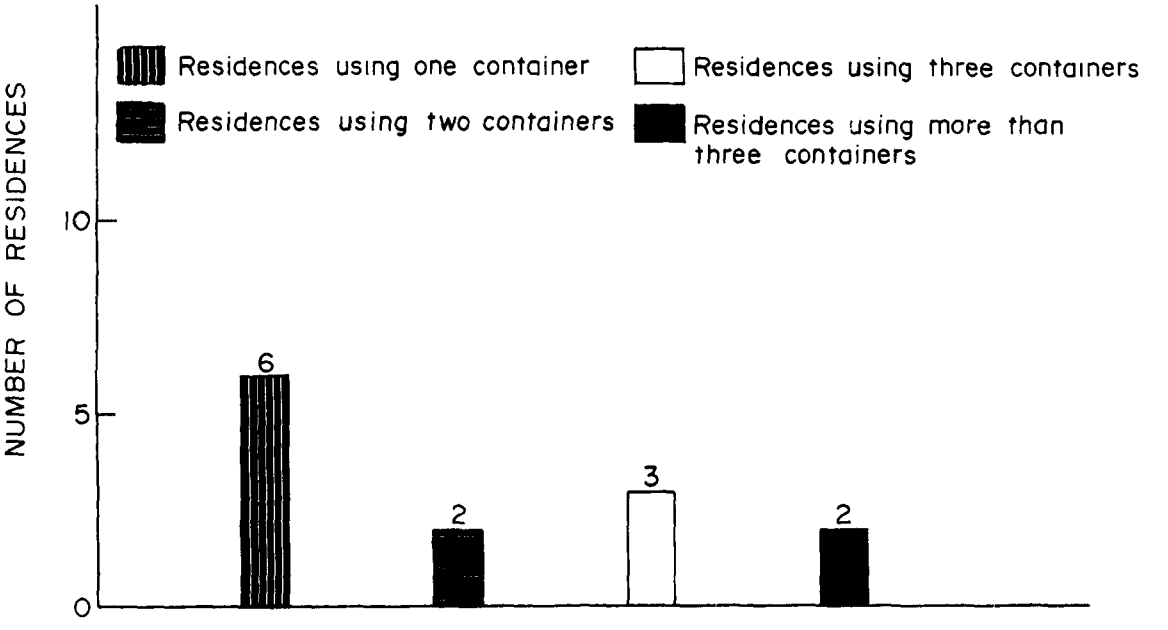

Figure 7. Distribution of residences on Guam using 32-gal waste-storage containers, by number of containers.

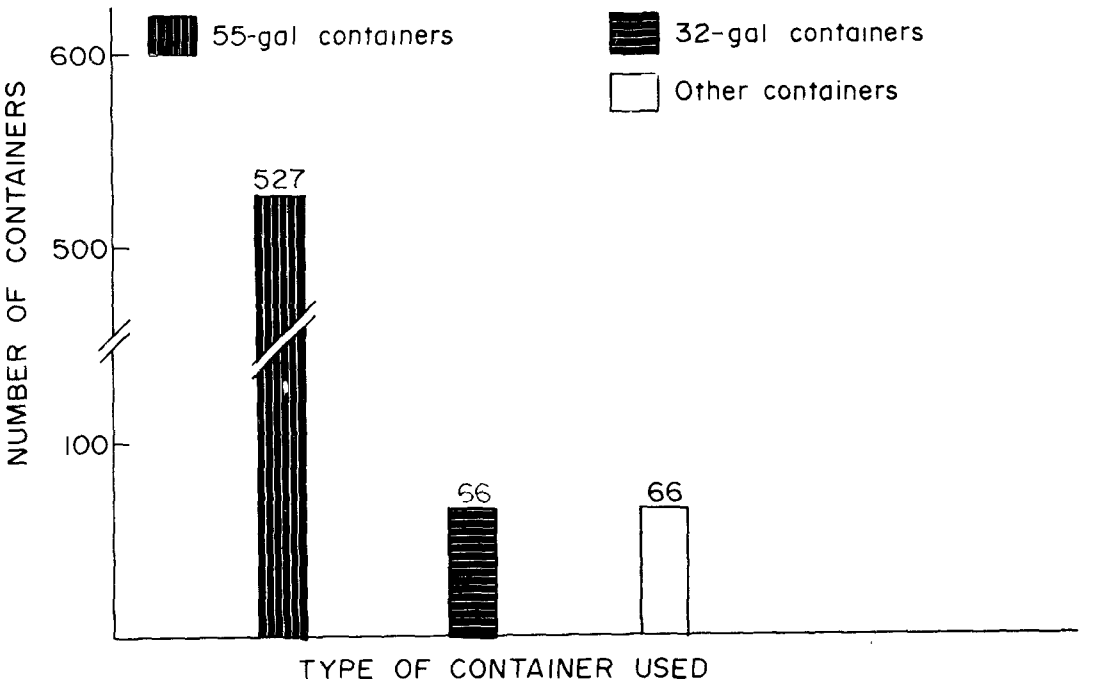

Figure 8. Distribution of waste-storage containers used on Guam, by container volume.

A total of 659 storage containers were observed during the survey. Of these, 80 percent were 55-gal drums, 10 percent were 32-gal containers, and 10 percent were different types (Figure 8). Seven percent of the 175 residences having only one 55-gal drum exhibited debris outside the containers. Ten percent of the 111 homes with two 55-gal drums had debris. One of the 14 residences with three 55-gal drums also had such debris. Therefore, it appears that the incidence of litter or debris is not really related to the number of containers available for storage.

Storage containers are generally kept at curbside (Figure 9), supposedly because of the unpredictability of collection, but also

Figure 9. Residential storage-container locations.

because 55-gal drums, which are the predominant storage containers, cannot be easily set out for collection. If smaller containers were used, solid waste could be stored out of sight at the rear of the houses and carried out for collection by the individual homeowner. Storage at the rear would also limit the access of children, dogs, and chickens to the stored waste.

Most containers are stored on racks that vary in height from a few inches to about 3 ft. Many are in need of repair, and some should be eliminated entirely because of their height and unsafe condition. Storage racks improve the sanitation of the storage area, but they should be limited from 12 to 18 in. in height and be soundly constructed in an acceptable manner. Use of racks would also allow lids to be tied to them to prevent loss in high winds.

Open burning is common both in and around cans (Figure 10). Such burning results in discoloration and rapid deterioration of the cans and contributes to air pollution. It also creates ashes that are blown when the container is emptied, thereby hindering the performance of the collection crews. If a fire is not completely out when a can is collected, it poses the additional problem of starting a fire in the collection vehicle.

Some residents have made an effort to improve storage practices by purchasing 32-gal containers. Both galvanized steel and plastic containers were observed. Many of the galvanized cans were of the heavy-duty, reinforced type used by the military. The use of these heavy cans should be discouraged because of their excessive weight (30-35 lb when empty).

Many of the residents using 32-gal containers also had 55-gal drums in the storage areas (Figure 11). It appeared to be common practice to fill the 55-gal drums with waste first and then to use the 32-gal containers for the excess.

The Government of Guam has made an effort to upgrade storage area appearances by selling painted drums through the Guam Rehabilitation Center. This approach does not consider the more important problems involved in collecting the 55-gal drums or the problems created by the lack of lids.

If solid waste handling and disposal is to be improved on Guam, one of the first steps must be the elimination of unsuitable storage containers.

Figure 10. Burning in storage containers.

Figure 11. Two 32-gal containers on rack (note 55-gal drums also present).

Acceptable containers should be enclosable to prevent insect and rodent infestation. To achieve this goal, containers should have tight-fitting lids and be free of holes. They should be cleanable and free from corners and edges where material may accumulate. Containers should be durable, capable of withstanding handling, and manageable. Their full weight should not exceed 75 lb. They should be equipped with handles and of a size that can be handled by one man.

The 55-gal drums do not meet any of these criteria and should be prohibited. Similarly, use of undersized containers (under 20-gal capacity) should be limited because of the excess handling involved in their use. Efforts should be made to encourage or require residents to use lightweight containers of 20- to 30-gal capacity.

Containers that do meet these criteria include galvanized steel cans and high impact plastic cans. If containers of sufficient durability were obtained, plastic containers would seem to be advantageous in the humid climate of Guam because of their resistance to corrosion.

Commercial and Institutional. Solid waste storage practices at commercial and institutional locations do not vary greatly from those at residences. The 55-gal drums are the predominant storage containers, with some locations having up to a dozen. All of the drawbacks of 55-gal drums discussed in the residential-storage section apply to commercial and institutional situations. The problems are amplified, however, by the necessity of using a larger number of containers per service.

Because of the large amounts of waste generated per day at commercial and institutional locations, large, bulk containers could be used. These usually vary from 1 to about 8 cu yd and are mechanically emptied into packer trucks.

Solid Waste Collection

Collection of solid waste on Guam is the responsibility of the Department of Public Works. To carry out this assignment they use three 20-cu-yd packer trucks, two 18-cu-yd top-loading packer trucks, and five 3-cu-yd dump trucks (the capacity of which has been increased to about 12 cu yd by providing side boards of wire mesh) (Figures 12-14).

One driver and two loaders work with each truck. On the dump trucks the driver also acts as a loader, so that two men lift the container onto the truck, and the other man, stationed on the truck, unloads the containers.

Solid waste is collected on a weekly basis from all residences and businesses. Commercial establishments can pay to have waste removed more frequently, if desired, or they can haul their own to the dumps. The hospital, schools, and government offices have their waste collected daily.

Normal collection operations are carried out between 7 a.m. and 3:30 p.m., with three trucks operating on a second shift from 3:30 p.m. to 12 midnight. Crews work six days a week with holidays off.

Figure 12. A 20-cu-yd packer truck.

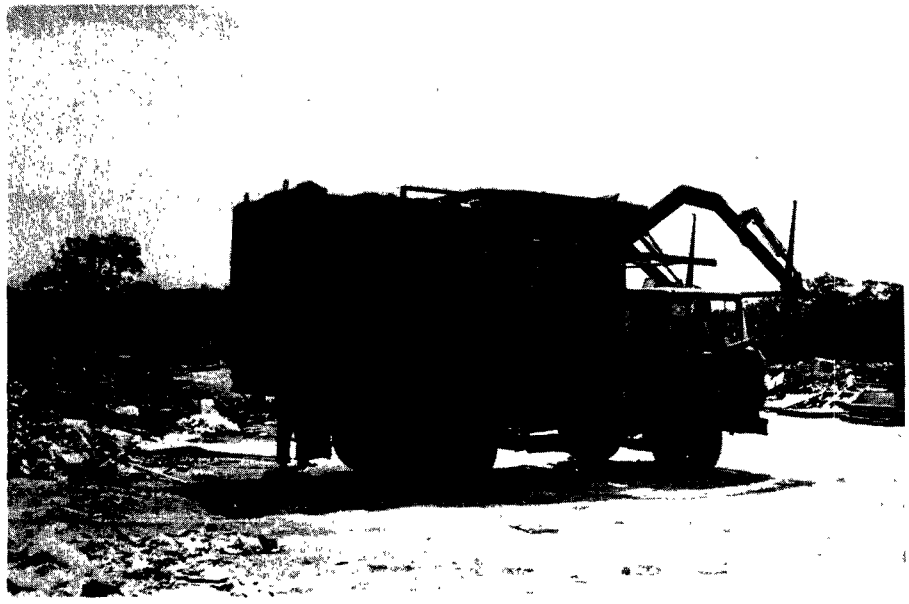

Figure 13. An 18-cu-yd, top-loading packer truck.

Figure 14. A 12-cu-yd dump truck.

Studies were made of collection-vehicle productivity (Appendix F). Productive time (Table 15) is defined as the time actually spent handling the items for collection. (Waiting time is that time when handling of waste stops to allow for moving the truck or packing the load. The off-route, or other time is avoidable delay time which can usually be decreased by closer supervision).

An examination of the data reveals several interesting items. The number of miles per minute, for example, does not show any significant variation from village to village or by type of collection truck. The number of services per mile, services per minute, and items per minute do, however, show definite differences between dump trucks and enclosed packing vehicles.

A regression analysis of the observed distances, numbers of services, and numbers of items was run against the productive times. This analysis allowed the determination of the relative effects that the three factors had upon the response variable. The results of the regressions are in the form of equations in which the productive times are expressed as functions of the route distance, the number of services, and the number of items for collection. It was found that the number of items for collection was the variable with the greatest effect on the productive time. The number of services was the next most important, and the number of miles traveled was the least.

A preliminary analysis of the data indicated that all of the information gathered on packer trucks (including the top-loader) could be

TABLE 15

PRODUCTIVITY OF COLLECTION VEHICLE BY TYPE OF TRUCK AND ROUTE

Type of truck and route	Services per mile	Services per productive minute	Miles per productive minute	Items per service	Items per productive minute
Packer					
Mangilao	54.2	2.15	0.04	1.08	2.31
Barrigada	60.0	1.29	0.02	2.36	3.04
Agat	65.0	1.70	0.03	2.01	3.42
Tamuning	70.7	1.93	0.03	1.74	3.36
Dempster Dumpster*					
Dededo	68.0	2.22	0.03	1.62	3.59
Dump					
Agana Heights	20.0	0.42	0.02	2.00	0.84
Merizo	26.8	1.07	0.04	1.28	1.36

*Mention of commercial products does not imply endorsement by the U.S. Public Health Service.

grouped and used to define a general equation for packer-truck productive times. Similarly, all of the data for dump trucks were combined, and one equation was determined. These two equations are shown below:

Packer: Productive time (minutes) = 2.84 × (miles) + 0.09 × (No. of services) + 0.21 × (No. of items) + 0.38

Dump: Productive time (minutes) = 8.63 × (miles) - 1.29 × (No. of services) + 1.40 × (No. of items) + 0.99

where

Productive time equals the time elapsed to collect a given area, multiplied by the fraction of productive time;

Miles equals the number of street miles that the collection vehicle travels in the area;

Number of services equals the number of waste sources collected from within the area; and

Number of items equals the total number of containers, bundles, or other objects that must be collected from the waste sources.

The equation for packer trucks explained 88 percent of the variation in the data, with a standard deviation of 23 percent of the response mean. Eighty-six percent of the variation was explained for dump trucks, with a standard deviation of 24 percent of the response mean.

If the physical characteristics (miles, services, and items) of the collection area are known, these equations can be used to predict the productive time necessary for collection.

During the period of study, it was found that an average of 1.82 items were collected per service (Table 6), and that there were approximately 65 services per mile (Table 15). A packer truck would therefore take 33.91 productive minutes and a dump truck 91.39 productive minutes to collect from a "typical" mile.

In addition to productive times, the waiting times and other daily times involved with collection were recorded (Appendix F). It was found that for packer trucks, productive time was 60.9 percent of the total time. Waiting time was 34.8 percent, and other time accounted for 4.3 percent of the total. The productive time for dump trucks was 69.0 percent, with 26.3 percent classed as waiting time and 4.7 percent as other time.

In order to calculate the total time for collection, it is necessary to add waiting time and other time to the productive time. For packer trucks, the waiting time is 57 percent of the productive time, and other time is 7 percent. Therefore, the total collection time for packer trucks is:

$$\text{Collection Time} = 1.64 \times (\text{Productive Time})$$

Similarly, for dump trucks, the waiting time is 38 percent and the other time is 7 percent of the productive time. The collection time can be calculated as:

$$\text{Collection Time} = 1.45 \times (\text{Productive Time})$$

The total collection time per "typical" mile, using a packer truck, is therefore 55.61 min. A dump truck will take 132.52 min. to collect the same mile--76.91 min. longer than a packer truck, or 238 percent as much time to collect each mile. The difference is principally due to the increased loading height of the dump trucks and the longer time necessary to unload each can.

Times to empty individual storage containers were recorded. Timing was begun when the can was lifted from the ground or stand and was terminated when the container was returned. The results show that the average time to empty a 55-gal drum into a packer truck was 0.18 min. The 32-gal containers were emptied into packer trucks in an average of 0.14 min--a time savings of 22 percent over the 55-gal containers. Since it was found that the average 55-gal drum contained only 4 cu ft of waste (Table 6), which is comparable to the volume of a 32-gal container, it must be assumed that the shorter emptying time is principally due to the fact that 32-gal containers are more maneuverable and easier to handle than 55-gal drums.

The normal practice of collection crews is to get the truck as close as possible to the storage containers. Such practice is a direct outgrowth of the use of the large, difficult-to-handle, 55-gal drums.

If 32-gal containers could be used exclusively, it would be possible for the truck to proceed down the middle or one side of the road, stopping where necessary for the containers to be carried to it. The time-consuming practice of backing the truck to get near containers would then be eliminated.

Although no clear cut picture of the savings involved can be drawn, an attempt was made to measure the decrease in collection time that would result from eliminating truck backups. Over a distance of 0.2 miles with 19 services, two backups were made by the collection truck. The driving time involved was 3.0 min. When the truck was driven down the center of the street, stopping at all services but not attempting to get close to the containers, the driving time was 2.0 min. This is a saving of 33 percent in collection time.

The weighing of residential waste showed that the average item set out for collection weighed 59 lb, with a low reading of 4 lb and a high of 158 lb. The average weight of loaded containers was 65 lb. The average empty weight of these same containers was 42 lb. Thus the waste (23 lb per container) weighed only 35 percent of the weight of the full containers.

The loading height of the Garwood* packers is 2.9 ft (Figure 15). The top-loading packer trucks have a loading height of 3.0 ft (Figure 16). The Chevrolet* dump trucks have a loading height of 3.8 ft with the tailgate down (Figure 17), 5.0 ft with the tailgate up, and 7.8 ft when loaded over the side (Figure 18). Therefore, the work (weight multiplied by distance moved) involved in loading a container into a dump truck is either 30, 70, or 170 percent greater than the work in loading a packer truck, depending on where the containers are loaded into the dump trucks.

*Mention of commercial products does not imply endorsement by the U.S. Public Health Service.

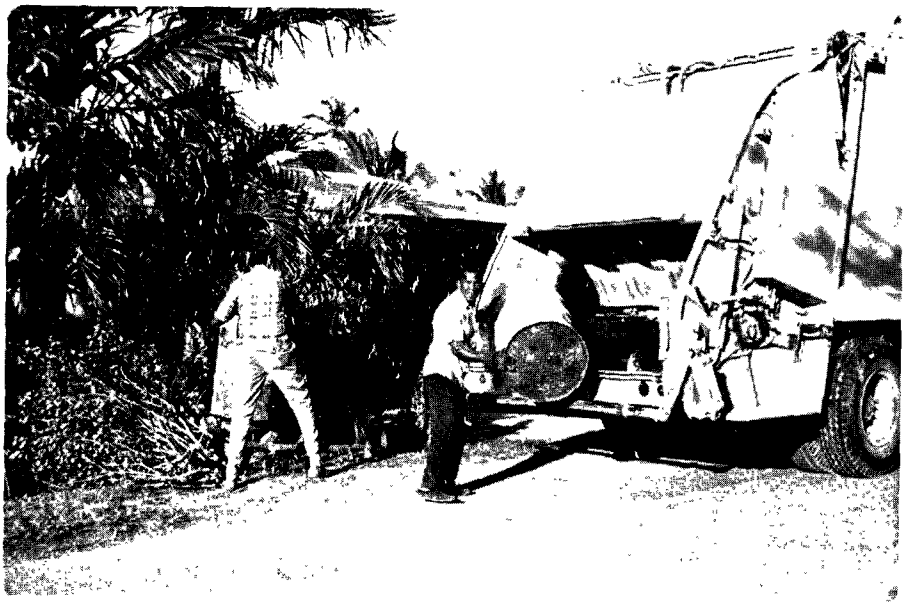

Figure 15. Loading a packer truck (note yard wastes).

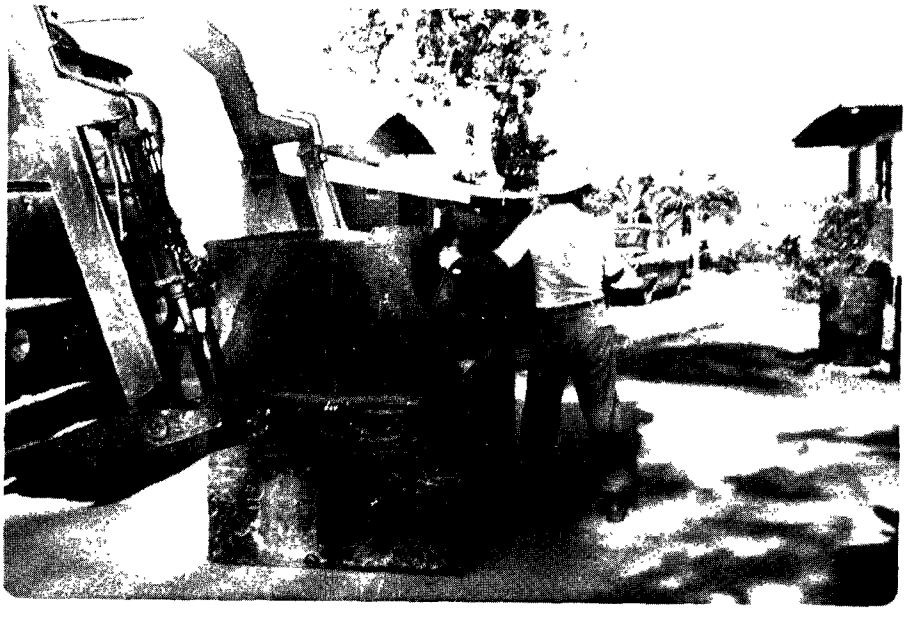

Figure 16. Loading a top-loading packer truck.

Figure 17. Loading a dump truck (tailgate down).

Figure 18. Loading a dump truck over the side.

The 32-gal galvanized containers commonly used for home storage have an average empty weight of about 10 lb. Their use would reduce the effort of the refuse collectors by 32 lb per container, or 49 percent. Plastic 32-gal containers weigh about 4 lb apiece. Their use would eliminate 38 lb of excess container weight, or 58 percent of the present full weight. Paper or plastic bags weigh practically nothing and would eliminate container weight entirely. They would result in a work savings of 65 percent over 55-gal drums.

Solid Waste Disposal

The solid waste collection crews dispose of the collected waste at five open dumps (located on the map of Guam in Figure 19).

The Yigo Dump (Figure 20) receives the waste from Yigo, Dededo, and Tamuning. It is located within sight of the highway to Andersen Air Force Base. There is no operational equipment at this dump, nor is there an operator or caretaker. Fires burn continually, and the smoke is generally carried into the village of Yigo.

Near Ordot is the largest of the five dumps (Figures 21-22). The Ordot Dump receives the waste from the populous middle section of the island. One bulldozer is at this site and an operator is on duty 8 hr a day. The operator directs the trucks to the dumping area, and the dozer pushes the waste to the edge of the filled area, where it is burned.

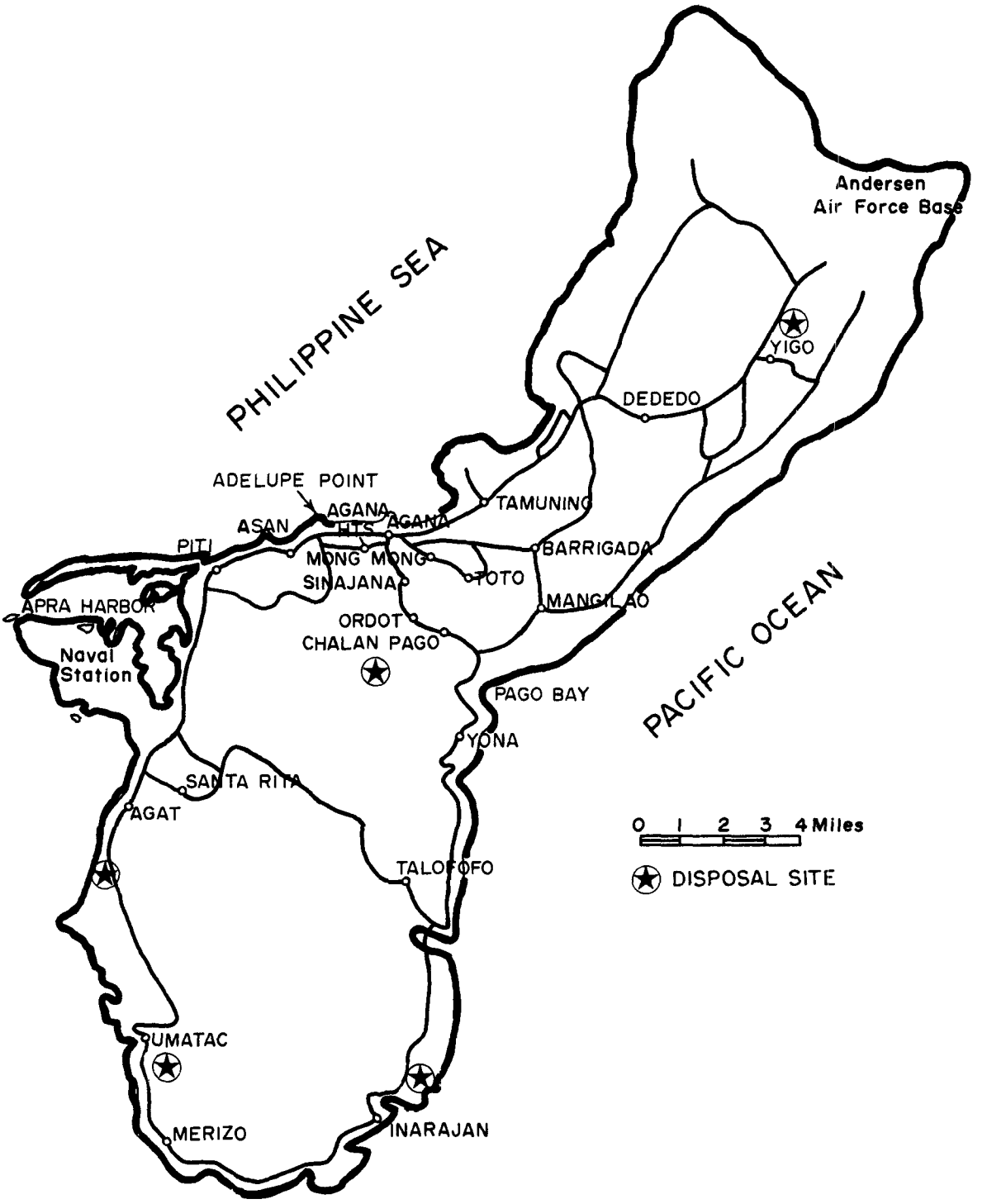

Figure 19. Solid waste disposal sites on Guam.

Figure 20. Yigo Dump.

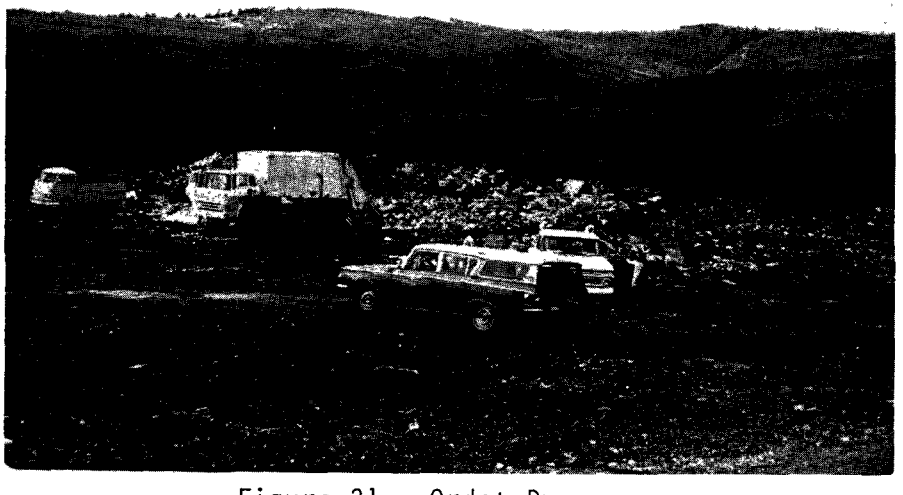

Figure 21. Ordot Dump.

Figure 22. Filled area of Ordot Dump.

Figure 23. Agat Dump.

The dump at Agat (Figure 23) receives waste from Agat and Santa Rita, and like the other dumps, it is usually burning. A caretaker is on duty to direct trucks to the dumping area.

Overlooking picturesque Umatac Bay is the Umatac Dump, which receives waste from both Umatac and Merizo. Because of the small quantities of waste, burning is not usually practiced. Instead, the paper is allowed to blow away.

The Inarajan Dump is located adjacent to the Inarajan water storage tank and receives waste from Inarajan and Talofofo. Burning is not common but does occur at times.

In addition to the waste hauled by the collection crews, many businesses haul their own waste to the dumps. The Ordot, Yigo, and Agat dumps receive most of these commercial wastes.

Scavenging is prohibited by law, but is practiced at all dumps. Ordot and Yigo were the two dumps where this was most evident.

The Government of Guam has proposed the closing of all five dumps and the establishment of one or possibly two sanitary landfills. It is recommended that this measure be undertaken as soon as possible. Aside from the health problems that burning dumps encourage by allowing rodents and insects access to the waste, by possibly polluting water supplies with runoff from the dump, and by polluting the air with burning materials, there is also the esthetic offensiveness of litter and smoke.

It would be difficult, however, to eliminate the outlying disposal sites until the present dump trucks could be replaced by packer

trucks. The smaller capacity of the dump trucks limits their effectiveness as collection vehicles if they must travel long distances to disposal sites. This consideration adds extra emphasis to the acquisition of high-capacity collection vehicles.

Management of Solid Waste Collection and Disposal

Organization. Solid waste collection and disposal is the responsibility of the Department of Public Works. Since the Department is undergoing a series of organizational changes at the present time, it is difficult to state what its structure is or will be. At the time of the study, however, the Refuse Division was organized with the collection crews under the direction of three area supervisors. The supervisors, who were new to the position and had no previous experience in solid waste management, were directly responsible to the Chief Engineer, who in turn was responsible to the Director of the Department of Public Works. Since the time of the study, one of the supervisors has become head of the Refuse Division and now has charge of the collection crews.

The operator and bulldozer at the Ordot Dump are loaned to the Refuse Division by the Highway Division. The operator's salary and the equipment costs are borne by the Division of Highways, and therefore, are not shown as part of the budget of the Refuse Division.

Equipment maintenance is performed by the Equipment Shop of the Department of Public Works. No obtainable records are kept that would allow the assignment of a vehicle operating cost to collection trucks.

Considerable delay is often experienced in obtaining equipment repairs, primarily because of the low priority given collection vehicles (below school buses and police cars). There are about 140 school buses and only 10 operational collection trucks. It is easy to see how repairs on a collection vehicle could be delayed quite a while with such a ratio.

Another cause for delay in obtaining repairs is the time that it takes to order spare parts from the U.S. mainland. Because of the long order time, one of the top-loading trucks is slowly being cannibalized to keep the other two running.

Manpower. Three men are assigned to each collection truck. The 10 operational trucks thus require 10 drivers and 20 collectors. Nine additional men work the second shift.

Drivers are usually paid a beginning salary of $3,588 and collectors, $3,172 (Table 16). Pay increases have been proposed in the fiscal year 1970 budget; the new level is to be set by the Legislature.

Crews report for work at 7 a.m. and leave on their routes as soon as possible. Quitting time is 3:30 p.m., and the crews are allowed a half hour for lunch. If a member is absent, many crews do not leave the Public Works compound until 7:30 a.m. or later because they must wait until a new man is assigned to them. Absenteeism reportedly is high. Second shift operation begins at 3:30 p.m. and stops at 12 midnight. Crews are usually kept intact as a unit--that is, they work on the same truck and collect the same routes weekly.

TABLE 16

DEPARTMENT OF PUBLIC WORKS PARTIAL PAY-RANGE SCHEDULE

Pay range	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9	Step 10
1	$2,912	$3,042	$3,172	$3,302	$3,432	$3,588	$3,744	$3,900	$4,082	$4,264
2	3,042	3,172	3,302	3,432	3,588	3,744	3,900	4,082	4,264	4,472
3	3,172	3,302	3,432	3,588	3,744	3,900	4,082	4,264	4,472	4,680
4	3,302	3,432	3,588	3,744	3,900	4,082	4,264	4,472	4,680	4,888
5	3,432	3,588	3,744	3,900	4,082	4,264	4,472	4,680	4,888	5,096
6	3,588	3,744	3,900	4,082	4,264	4,472	4,680	4,888	5,096	5,304
7	3,744	3,900	4,082	4,264	4,472	4,680	4,888	5,096	5,304	5,512
8	3,900	4,082	4,264	4,472	4,680	4,888	5,096	5,304	5,512	5,772
9	4,082	4,264	4,472	4,680	4,888	5,096	5,304	5,512	5,772	6,032
10	4,264	4,472	4,680	4,888	5,096	5,304	5,512	5,772	6,032	6,292
11	4,472	4,680	4,888	5,096	5,304	5,512	5,772	6,032	6,292	6,552
12	4,680	4,888	5,096	5,304	5,512	5,772	6,032	6,292	6,552	6,864
13	4,888	5,096	5,304	5,512	5,772	6,032	6,292	6,552	6,864	7,176
14	5,096	5,304	5,512	5,772	6,032	6,292	6,552	6,864	7,176	7,488
15	5,304	5,512	5,772	6,032	6,292	6,552	6,864	7,176	7,488	7,800
16	5,512	5,772	6,032	6,292	6,552	6,864	7,176	7,488	7,800	8,112
17	5,772	6,032	6,292	6,552	6,864	7,176	7,488	7,800	8,112	8,502
18	6,032	6,292	6,552	6,864	7,176	7,488	7,800	8,112	8,502	8,892
19	6,292	6,552	6,864	7,176	7,488	7,800	8,112	8,502	8,892	9,282
20	6,552	6,864	7,176	7,488	7,800	8,112	8,502	8,892	9,282	9,672
21	6,864	7,176	7,488	7,800	8,112	8,502	8,892	9,282	9,672	10,192
22	7,176	7,488	7,800	8,112	8,502	8,892	9,282	9,672	10,192	10,712
23	7,488	7,800	8,112	8,502	8,892	9,282	9,672	10,192	10,712	11,232
24	7,800	8,112	8,502	8,892	9,282	9,672	10,192	10,712	11,232	11,752

Source: Government of Guam Employee Handbook.

Legislation. Solid waste collection and disposal on Guam is governed by Subchapter Q of the Government Code of Guam, entitled "Garbage and Rubbish" (Appendix H), and by Chapter 55 of Title XXXII, entitled "Housing Code." These acts provide that:

1. Garbage should be stored in durable, metal containers.
2. Waste receptacles must be tightly covered while stored.
3. Rubbish may be bundled.
4. No waste can be disposed of except in authorized public dumps.
5. No open burning can be done within $\frac{1}{4}$ mile of any urban area.
6. The Department of Public Works will collect and dispose of solid waste.
7. Solid waste cannot be transported in open vehicles unless provisions are made to keep waste in the vehicle.
8. The Director of Public Works has the authority to prescribe additional regulations concerning storage containers.
9. No persons except those having material to dump shall be permitted on any public dump.
10. Collection shall be furnished in all village and urban areas without charge to private residences.

Budget. The proposed budget for the Refuse Division for fiscal year 1970 is $520,312--about 9 percent of the total proposed budget of the Department of Public Works. It ranks behind schools, whose allotment has been set at $3,146,939, and highways, whose budget is at $863,512.

The Refuse Division's budget for fiscal year 1969 is $259,197, or 5.5 percent of the total for the Department. The fiscal year 1968 budget was $217,475, or 6.6 percent of the total. These figures show not only the monetary increase in the Division's budget, but also the increase in awareness of the importance of solid waste management as reflected in the percentage increase from about 6 percent in 1968 and 1969 to 9 percent for FY 1970.

Resources for the Refuse Division are primarily obtained from tax funds. No charges are made for residential clients. Businesses desiring collection more frequently than once a week can contract with the Department and pay for additional collection.

Solid Waste Management on Military Bases

The United States Navy and Air Force are the largest employers on Guam. There is also a sizeable population of military personnel and dependents on the island. Solid waste on the bases is collected and disposed of by the respective commands. Agana Naval Station and Andersen Air Force Base are the two largest installations and, therefore, produce the largest amounts of waste.

Naval Operations. The Navy uses four collection systems:

1. Dempster Dumpster* units are used at the port area and other work areas and are emptied on call when full.
2. Dempster Dumpmaster* units are used in housing and office areas (Figures 24 and 25). One bulk container is used for four

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Figure 24. Bulk containers (Naval Station).

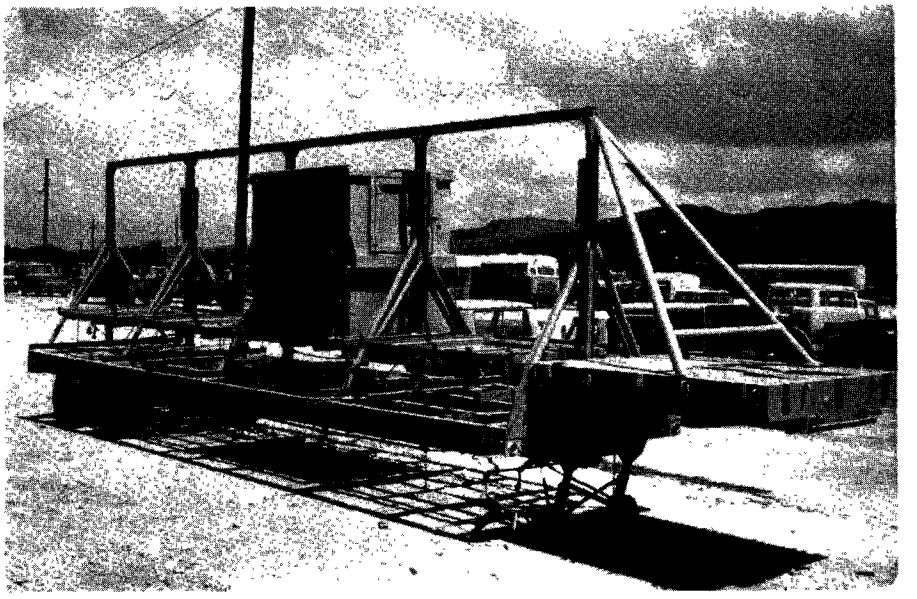

Figure 25. Large bulk container (Naval Station).

houses, and each is situated on a concrete pad. They are serviced with front-loading packer trucks and are regularly cleaned and periodically repaired. Specially built trailers are used to transport the containers to a central repair and cleaning site. Cleaning is done with hot water and detergent. Each unit can be tilted by hand while on the trailer and can therefore be cleaned without being removed. In an effort to extend the life of the containers, each new one is reinforced and painted inside with an epoxy coating. Observation of the Navy system indicates that maintenance and cleaning are important aspects of using bulk containers in residential areas.

3. Galvanized can storage is used in the Commissioned Officer's housing area. Two cans are provided per house, and they are serviced by rear-loading packer trucks.

4. Transfer trailers with self-contained compacting mechanisms are used at two sites: (a) at the commissary (Figure 26) where large amounts of cardboard packaging waste is produced and (b) near the port area and other work areas where some of the Dempster Dumpster* units are emptied into the transfer trailer.

A disposal method once used by the Navy was a "shark pit." Food waste from the dining areas was dumped down a chute into the sea (Figure 27). Now, however, a sanitary landfill is operated on the Naval Station (Figure 28), and a new landfill has recently been opened on the

*Mention of commercial products does not imply endorsement by the U.S. Public Health Service.

Figure 26. Stationary compactor (Naval Station).

Figure 27. "Shark pit" disposal site (Naval Station).

Figure 28. Sanitary landfill (Naval Station).

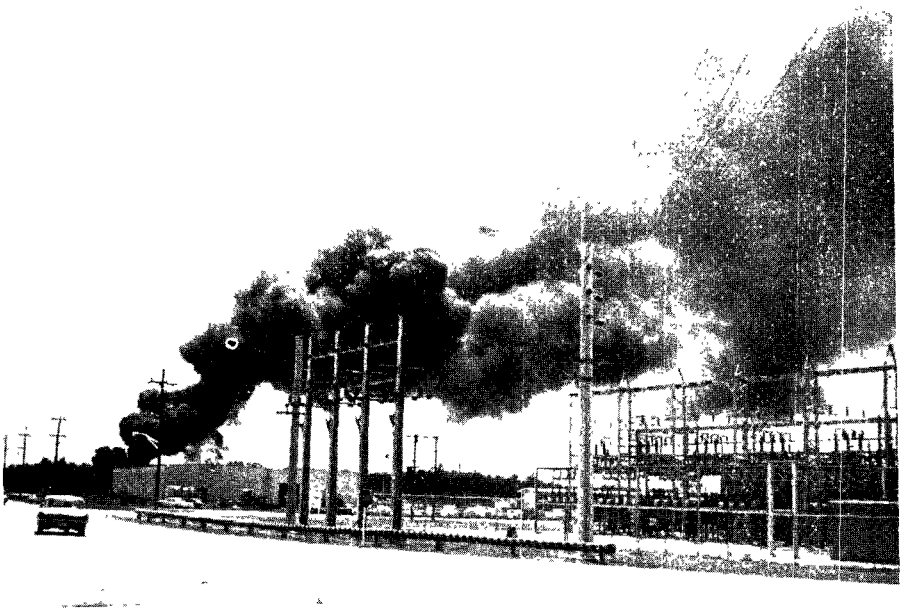

Figure 29. Disposal of waste oils (Naval Station).

Naval Air Station. Galley wastes are disposed of by contract to a pig farmer.

Waste oils are disposed of by burning whenever the need arises. This practice contributes to air pollution and is esthetically objectionable (Figure 29).

The Navy reportedly disposed of 650,000 cu yd of solid waste per year. If the density of commercial waste of 5.6 lb per cu ft is assumed for this waste, this volume is equivalent to about 48,000 tons per year. Of this amount, 83 percent goes to the Naval Station landfill, and 17 percent goes to the landfill at the Naval Air Station.

Andersen Air Force Base. The Air Force uses bulk containers (Figure 30) for waste storage in work areas and on the flight line. Individual cans and rear-loading packers are used in housing areas. The containers are carried to the dump and emptied into a previously dug trench (Figure 31). Waste in the trenches is burned and the trenches are covered when filled with the noncombustible materials and ash (Figure 32). Bulky wastes, including packaging materials, are hauled to a different site and burned (Figure 33).

The Air Force estimates its yearly waste production at 390,840 cu yd. At a density of 5.6 lb per cu ft, this becomes about 30,000 tons per year. Figures for both the Navy and Air Force are based on the assumption that all containers are full when collected. It is therefore reasonable to assume that the actual amounts of waste are somewhat lower than reported.

Figure 30. Storage containers (Andersen Air Force Base).

Figure 31. Trench landfill operation (Andersen Air Force Base).

Figure 32. Burned waste (Andersen Air Force Base).

Figure 33. Dump for bomb cartons (Andersen Air Force Base).

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This study required the cooperation of many people and organizations. The Division of Technical Operations extends sincere appreciation to the personnel of the Department of Public Works, to the Department of Health and Social Services, and to the village commissioners for their help and encouragement during the course of the study. Our thanks go also to Mr. Denver Dickerson, Secretary of Guam and Acting Governor during the period of the study, for his assistance and interest.

In particular, we wish to acknowledge the cooperation of Richard A. Coddington, Environmental Health Administrator, and Thomas Yamamoto, Chief Engineer, Department of Public Works. Special thanks go to Jose C. Guerrero and Benny Perez for their help during the study. Jesus G. Soriano and Gangalo A. Garcia also provided needed assistance.

The personnel of the Division of Technical Operations and the Bureau of Solid Waste Management who have helped in the preparation of this report are also gratefully acknowledged.

APPENDICES

APPENDIX A

REPORT OF OBSERVATIONS ON SOLID WASTE MANAGEMENT PRACTICES ISLAND OF GUAM, NOVEMBER 1968

by Donald M. Keagy*
and Jack DeMarco†

I. Introduction

In August, 1967, the Department of Public Health and Welfare, Government of Guam, submitted an application to the Public Health Service for a solid waste disposal demonstration project grant. Since that time a number of written and verbal exchanges of communication occurred between members of the two agencies relative to the problem in general and the application in particular. Although the application was disapproved, there was a mutual recognition of the need for technical consultation to the Government of Guam by the Solid Wastes Program, Environmental Control Administration, Public Health Service, Department of Health, Education, and Welfare. Accordingly, the Regional Program Chief, Region 9, and the Deputy Chief, Technical Services, authors of this report, made a field visit to Guam August 4-7, 1968, for the purpose of making a general assessment of the solid waste situation on the Island. At the conclusion of the visit, we promised to provide a report of our findings and recommendations.

We were accompanied the entire time by Mr. Richard Coddington, Environmental Health Administrator, Department of Public Health and Welfare. A tour of the Island was made which afforded views of representative storage conditions of all five of the open-dump disposal sites for the civilian population. Although study of the Navy and Air Force solid waste disposal systems was not originally scheduled or planned, advantage was taken of the opportunity afforded to visit and become acquainted with the situation at Andersen Air Force Base and the Navy base. Interviews were held with key officials in the Department of Public Works, but regrettably, the weather precluded a planned direct observation of collection practices employed by that Department. A

*At the time of the report Mr. Keagy was serving as Regional Program Chief, Region IX, Solid Wastes Program. He is currently the special assistant to the Commissioner for Regional Operations, Region IX.

†Mr. DeMarco was formerly Deputy Chief, Technical Services, Solid Wastes Program. He is now serving as Deputy Director, Division of Technical Operations, Bureau of Solid Waste Management.

significant amount of time for dialogue was kindly made available from time to time by the Acting Director of Public Health and Welfare. Advantage was taken of an opportunity to meet with 10 of the District Commissioners for about 1 hr at the time of one of their regular meetings. Lastly, the visitors accompanied Mr. Sanchez, Mr. Coddington, and Mr. Perez, and were afforded the opportunity to have a 1½-hr conversation with Governor Manuel Guerrero on this subject. All of the persons contacted were most generous with their time, cooperation, and sharing of information and data.

This report is the product of not only first-hand observations but also a rather careful later analysis of the volume of data and information collected during the visit, including the January 1966 report of Eldon P. Savage and the September 1967 "Reorganization Plan--Solid Waste Disposal" prepared by Albert E. Bertram.

In general, it can be said that the Public Health Service team concluded that the 1966 and 1967 reports of Savage and Bertram provided basic and useful data and information to the extent feasible under the circumstances.

This report should be viewed as an amplification of and supplement to those two reports.

II. Findings

A. GOVERNMENT OF GUAM

Storage

The general condition of solid wastes storage on the Island of Guam is highly unsatisfactory. The following observations were made during our brief visit.

1. The prevalent type of residential storage container observed was the 55-gal drum, without cover. In our discussions we were informed that holes were routinely punched in the bottom of the drums to prevent water from collecting in them.

2. Only in the community of Merizo did we observe any widespread attempts to provide covers for the 55-gal drums. Although this was an indication of a willingness to upgrade conditions, the 55-gal drum is not amenable to the type of tight-fitting cover required for a satisfactory storage container.

3. The container showed evidence that frequent cleaning was not a general practice. The size and shape of the 55-gal containers do not lend themselves to easy cleaning.

4. In addition to the 55-gal drums, make-shift containers, such as cardboard cartons, were observed in use.

5. The 55-gal storage containers provided a difficult situation for handling by the householder and the collection crew.

6. The storage areas observed at some residences and commercial districts frequently amounted to open dumping.

7. Large numbers of flies were observed at many storage areas.

8. Evidence was observed that open burning was practiced at some storage areas.

9. The location of residential storage containers at the curb line of streets does not provide an aesthetic attraction to the Island of Guam. Unsightly solid waste storage areas provide an incongruous and demoralizing effect where residents are attempting to improve the beauty of their homes and overall appearance of their communities.

Collection

The collection service provided by the Public Works Department was the object of island-wide complaints. The complaints seemed to be well founded on the basis of the lack of adequate planning, supervision, and equipment necessary to provide a satisfactory system. The following observations were made:

1. The personnel were reported to have a high amount of absenteeism. This amounts to approximately 20 percent of the work force being absent each day. Personnel with medical dispensations were employed because of difficulties in securing people for the vacancies posted.

2. The lack of supervision of employees is evidenced by the vacancy existing in the full-time superintendent position for the garbage and trash division. Employee orientation

and safety programs cannot be adequately carried on without the supervisory personnel required.

3. The three 18-cu-yd, front-end-loading packer trucks were reported to be in poor condition. Only one or two were reported to be kept in service because of maintenance requirements. The packer type of equipment is acceptable for a collection system, but the number available should be sufficient so that a proper maintenance and service program will not interfere with the normal operations of the system. The two additional packer trucks reported to have been ordered will not likely satisfy the requirements for an adequate number of vehicles.

4. The five to seven open body trucks in use are not a suitable type for collecting solid wastes with an organic fraction. In addition to the objection from a public health viewpoint, these vehicles pose problems to the safe and efficient handling of solid wastes.

5. The daily records of the collection system operation, although helpful, were not adequate for evaluating its effectiveness, nor for use in revising the present collection system to meet future needs.

6. An evaluation of the routes and methods used was not available. It seemed evident that no attempt was made to evaluate or re-evaluate the efficiency of the present system for the purpose of optimizing its operation, even with its known deficiencies such as lack of equipment.

7. A route map of the collection system was not available. A route map, along with daily operation records and a periodic evaluation serves as an operational method of maintaining a proper collection system.

8. The present collection system is not responsible to the justifiable complaints of the public. The District Commissioners reported that solid waste collection was the subject of their most frequent complaints. They advised that in their opinion, the public is willing to pay a fee to receive proper collection service. An improved system would have to be put into effect before such a fee could be assessed.

9. The frequency of collection of residential solid wastes, although planned for once a week, was reported to be irregular and less than once a week in actual practice. It was reported that one 55-gal drum per week is the amount that collectors are instructed to collect. The amount of solid wastes noted at the residences in many instances was more than could be contained in one 55-gal drum or an equivalent number of smaller containers. This would indicate that the current frequency of collection and/or limitation on the amount collected is inadequate for the needs of the public.

Disposal

The five land disposal sites visited all classify as open-burning dumps. These sites are the classical type at which nuisances, vectors, obnoxious smoke and odors, are insults to the general public. Also they are needless degradations of the environment. Roadside dumping was observed at various locations on the Island. Junked automobiles were also prevalent in many locations. Solid waste disposal practices on the Island of Guam are in need of major improvement.

Management

A proper solid waste system requires supervision of each facet of the system along with overall supervision to insure that the component parts are integrated into an efficient solid waste management system. Thus, the key to starting and maintaining an efficient solid waste storage, collection, and disposal system is good management. This lack of management is one of the major causes for the poor solid waste practices on the Island of Guam.

B. MILITARY

A brief visit to the Naval Air Station and Andersen Air Force Base was made to observe their solid waste management practices.

Naval Air Station

In general, their collection system seemed adequate and the storage areas appeared neat and sanitary on the day of our visit. Front-end, container-loading packer vehicles are used. There seemed to be adequate supervision to maintain a constant check on their system.

The previous ocean-dumping practice (shark pit) is reported to have been discontinued, and sanitary landfilling is their current disposal method. Discussions and a brief visit to their operation indicated that daily cover, no open burning, and other proper sanitary landfill techniques were being utilized. The site has reportedly been operated as a sanitary landfill for approximately 4 months with the purpose of reclaiming low-lying lands.

Andersen Air Force Base

Our brief visit to this Air Force installation resulted in the following observations:

1. Records of the collection system operation are kept.

2. Rear-end loaders are used.

3. Backyard collection is provided.

4. Twice-weekly collection is provided for housing units.

5. Garbage from dining halls is collected daily.

6. Dempster Dumpster* storage containers are placed at other locations and are collected using a "call system."

7. Dempster Dumpster* containers are scheduled for weekly cleaning.

8. An entomology unit conducts a cleaning program for containers, collection vehicles, and storage areas.

9. The disposal operations were carried on at several locations, with open burning practiced at each. One site was a trench-type operation, where the burned solid wastes were covered periodically.

III. Discussion of Findings

A. GENERAL

The most significant conclusion we have drawn from our observations and findings is that there is insufficient data available to properly develop a comprehensive solid waste management plan for Guam. This is not to say that a number

*Mention of commercial products does not imply endorsement by the U.S. Public Health Service.

of significant activities cannot be initiated immediately to ameliorate the problem but that sooner or later considerably more data will need to have been collected before the Government of Guam can achieve an optimum solid waste management system.

Many of the observations pointed out in the previous section have been brought to the attention of the Government of Guam in both a study conducted by the Public Health Service by Mr. Eldon Savage (1966) and also in a proposed reorganization plan for Guam's Solid Wastes Disposal Program prepared by Mr. Albert E. Bertram, Sr., Sanitary Engineer on assignment with the Government of Guam. The consensus of these previous two reports is in general agreement with our observations, in that all phases of solid waste management on the Island of Guam indicate a lack of adequate planning, supervision, and financial resources to appropriately cope with the solid waste problems on Guam. This situation should not be allowed to continue. Continuing study of the problems will not result in an upgrading of general conditions, unless these studies are backed to every degree possible by an action program.

B. SPECIFIC

1. Government of Guam

Storage

The obvious result of the poor storage practices being followed on Guam is the unsightly conditions present in most storage areas observed. The not so obvious, but yet more important results of these poor storage practices, are the influences that they may have on public health and also the efficiency of the collection system.

It is common knowledge that flies and other vectors are attracted to and proliferate in solid wastes. The function of proper storage is to minimize these breeding grounds in every way possible so as to prevent nuisances and potential health hazards to the public. Open storage containers, containers with holes, open dumping of solid wastes, make-shift containers, and unclean or uncleanable storage containers are all conditions which directly oppose the achievement of the goals of good storage practices. Since all of the improper conditions exist in the present system, there should be little doubt as to the need for rectifying the situation.

A further consideration of proper storage is the effect that it has on the efficiency of the collection system. If more than one proper storage practice can be followed, it is only good planning to select that method which most aptly aids the proper collection of solid wastes. The 55-gal storage container, as well as the other storage practices present in Guam, do not aid collection efficiency, but rather deter it. Thus, the unmanageable 55-gal storage containers, along with aiding and abetting nuisance problems, etc., promotes an inefficient collection system on Guam.

To promote a more aesthetic appearing community, many communities keep their containers at locations other than the curb line in front of houses. This entails either the homeowner placing the container at the collection point on the assigned day or that a set-out and set-back, or backyard-carry collection system be provided. Before Guam can change the location of its storage containers, it must carefully consider the impact it will have on the collection system. It would seem that until the 55-gal containers can be abolished and a regular frequency of collection can be established, the current storage container location should be maintained. The environmental health group could institute a program of educating the public on effective ways of maintaining proper storage areas. This would include information on topics such as storage racks, methods and materials for cleaning containers, and the need for wrapping putrescible fractions such as food wastes. The sanitarians on Guam would seem to be capable of providing the guidance required.

Collection

The interrelationship between proper storage and collection was pointed out in the reports by Savage and Bertram. We would strongly remind the Government of Guam that no amount of effort to upgrade storage areas and practices will succeed without a proper collection service. Thus, the suggested improvements in storage practices will not prevent environmental health problems if the solid wastes are not routinely collected from these areas. The current collection system on Guam must be considered as a major obstacle in upgrading solid waste management on the Island. The previously stated findings

indicate some of the shortcomings observed during our brief visit. It is not the purpose here to attempt to design an adequate system, but rather to emphasize the gross neglect observed during our visit. An efficiently run collection system cannot be initiated or maintained with only a token gesture of interest in its success. Consequently, adequate supervision in all phases of the collection system as well as storage and disposal is a fundamental requirement that must be resolved by the Government of Guam. Upon providing adequate supervision for a collection system, it can undertake the maximum use of the existing resources and the development of required additional resources. Even if the maximum use could be made of the existing equipment, it is doubtful that proper collection service could be provided. It is apparent that the collection equipment currently used on Guam is not sufficient to accomplish proper collection. Additional appropriate type packer vehicles will be required as was pointed out in previous reports. These collection vehicles, along with appropriate containers, should help to reduce the problems of excessive absenteeism now experienced. Proper loading heights help to reduce unnecessary strain on the collection crew and can help to maintain a happier work force.

Other items of an effective collection system will also have to be initiated. This includes items such as routing maps and periodic evaluations, daily records, maintenance programs, safety and training programs, and established collection frequencies. The routing of collection vehicles will depend on what decision is made as to the disposal site or sites that Guam is to utilize.

Disposal

An unsatisfactory method of using land for disposal on Guam was prevalent. All of the classical problems previously mentioned in the findings can be minimized by following proper sanitary landfill practices. The use of five proper sanitary landfill disposal sites would not be necessary if one central site could be located. Previous reports seem in conflict as to whether transfer operations are necessary or not. Nevertheless, the reports are in agreement that one central disposal site near Ordot would be appropriate. Proper equipment and procedures must be utilized so that satisfactory and even exemplary operations can be insured. Selection of a disposal site will

have an impact on the collection system. Therefore, consideration of the collection and disposal system should not be performed independently of one another.

Management

Good management cannot be over-stressed in correcting the evils of poor solid waste storage, collection, and disposal practices. If one component of the overall solid waste management system receives little attention, the operation of the other components may well face problems that raise cost and decrease effectiveness. This was pointed out for the storage-collection operations, but can be equally true of the collection-disposal operations. Therefore, the overall system of storage, collection, and disposal should be kept in mind when improvements are initiated.

2. Military

The results of site visits to the Federal facilities indicated that the Government of Guam could benefit from a liaison with the solid waste management personnel located at these installations. The storage, collection, and disposal practices in general on the military establishments were superior to those observed elsewhere on the Island. The Navy sanitary landfill operation observed could serve as an illustration of what the Government of Guam could accomplish with the proper motivation. Similar instances of an improved storage collection practice could also be observed on the military installations. There seemed to be a willingness on the part of all concerned to cooperate in discussions of their mutual problems.

IV. Recommendations

It is recommended that the Government of Guam:

1. Assign a high priority to resolution of its solid waste management problem.

2. Provide the necessary increase in personnel, facilities, and funds to accomplish proper solid waste management practices in Guam which includes:

   a. Achievement of the long range goal of development of a comprehensive solid waste management plan, and

b. Achievement of short range goals of improvements of current practices.

3. Initiate action as soon as possible to achieve the long range goal of development of a comprehensive solid waste management plan by either:

   a. Contracting with one of several consulting engineering firms currently available in the U.S., or

   b. Utilizing the staff of Guam's solid waste management agency with whatever assistance the Solid Wastes Program can provide within the limit of its resources.

4. Initiate action as soon as possible to achieve the following short range goals toward improvement of current practices:

   a. Abolish use of 55-gal containers in favor of containers that are totally enclosed, easily cleanable (or one-time use), durably constructed, and easily handled by one man.

   b. Promulgate instructions or regulations for the proper cleaning of reuseable containers.

   c. Promulgate instructions or regulations for the proper support of containers or suitable racks or storage posts.

   d. Permit an adequate number of containers so as to allow storage of all solid waste in proper containers at each collection point.

   e. Exert a concerted effort to fill the vacancy of supervisor of the collection crews.

   f. Identify on a large scale map each source of solid waste (point of generation) on the Island identified as to type of source (i.e. household, commercial, educational institution, public building, industry, government building, hospital, recreation area, airport, agriculture, etc.) and as to whether collection, if provided, is by private or public collector.

   g. Identify on a transparent overlay of this map the current daily route of each collection vehicle.

h. On the basis of this map, evaluate collection services currently being provided and revise collection routes so as to provide reasonable and uniform services--putrescible wastes should be collected at least twice a week whenever and wherever possible.

i. Explore the feasibility of augmenting the currently insufficient collection equipment and manpower through the utilization of private collection services.

j. Exert a concerted effort to identify the cause of delay in delivery of the (three) new packer trucks ordered in FY 1968 and to expedite their delivery.

k. Select a central disposal site and operate it as a sanitary landfill.

l. Discontinue the practice of using the existing open-burning dumps, and initiate proper dump-closing procedures, which include a vector elimination program, compaction and grading of the waste material, and application of at least 2 ft of compacted earth cover graded to promote good drainage.

m. Outlaw open burning and indiscriminate dumping.

n. Review and amend, as necessary, existing statutes and regulations so as to be consistent with these recommendations.

APPENDIX B

SAMPLE SIZE TO DETERMINE SOLID WASTE DENSITIES

This analysis is related to the mathematical concepts and techniques used to develop the suggested number of samples for determination of solid waste densities.

Based upon the exact formula for constructing a confidence interval about an average ratio, the following approximation is considered applicable to solid waste studies:

$$n = \frac{t_{\alpha}^2 \, V(A)}{B^2 \delta^2} \qquad (1)$$

where n = sample size
t_{α} = constant obtained from a t-table at an α% risk level
$V(A)$ = variance of the numerator of the ratio involved (lb)
B = the average of the denominator of the ratio involved (cu yd)
δ = required sensitivity (δ = one-half the maximum confidence interval desired about the average ratio)

It is recognized that few investigators will have an adequate estimate of either $V(A)$ or B. Studies in the Cincinnati area have found, however, that in almost 90 percent of all cases, the quantity $V(A)/B^2$ was less than or equal to $25\bar{X}$, where $\bar{X}$ is the mean density of the wastes. At a risk level of 10 percent, an acceptable value for t_{α} is 1.645. Thus, equation 1 simplifies to:

$$n = \frac{68 \, \bar{X}}{\delta^2} \qquad (2)$$

Equation 2 can now be used to determine the sample size required to make an estimate of any generation variable if (a) an estimate of the mean is made and (b) the desired sensitivity is stipulated.

From the same Cincinnati tests, the value of $\bar{X}$ was found to be about 160 lb per cu yd. If we desire the density within 10 lb per cu yd, then:

$$n = \frac{68\ (160)}{(10)^2}$$

$$n = 108.8$$

Therefore, 109 samples must be taken to determine the density of the waste.

APPENDIX C

SOLID WASTE SEPARATION

Five separations of residential solid waste were performed in an effort to determine the composition. Samples of approximately 200 lb were dumped onto a tarpaulin directly from a filled collection vehicle. These samples were then hand-separated into the following categories:

Food waste--Waste resulting from food preparation, primarily putrescibles.

Garden waste--Yard trimmings, leaves, and brush (twigs and branches are included in this category if they have diameters of less than 1 in.).

Paper products--Wrapping paper, newspaper, cardboard, and other similar items.

Plastics, rubber, leather--Plastic film, packaging, and rubber and leather items.

Textiles--Natural and synthetic fabrics.

Wood--Wood or wood products with diameters in excess of 1 in.

Metals--Both ferrous and nonferrous metals (primarily cans, with some wire, metal foil, and heavy, bulky items).

Glass and ceramics--Mostly bottles and jars with some noncombustible ceramic materials.

Ash, rocks, dirt--Noncombustible items that are too small to be separated into another category.

The guiding principle behind the separation was to obtain groups of materials having similar physical and chemical properties. Appropriate care was taken to place each item into the correct category, but it was not worthwhile to attempt to separate labels from cans or to make other similarly minute divisions. Such materials were placed in the category that most closely fit their major weight classification.

After the waste was separated into the nine components, each component was weighed. The percentage composition on a weight basis was then calculated for each component (Text Table 8).

APPENDIX D

MOISTURE-CONTENT DETERMINATION

Solid waste moisture-content determinations were obtained for separated waste on 4 different days. Samples of food waste, garden waste, paper products, and textiles were extracted from the separated components. Metals, glass and ceramics, and ash, rock, and dirt contain negligible moisture and were therefore excluded. Since a laboratory grinder was not available, it was not possible to include plastics, rubber, leather, and wood in the moisture sample. Moisture calculations were adjusted for the omission of these materials by using data obtained in previous studies.[a,b]

The laboratory procedure for determining moisture content was to place the sample and its container in a drying oven at 70 C for approximately 24 hr. The first sample was dried in the combined form, and subsequent samples were dried by individual categories.

Table D-1 gives the percentage moisture content for each sample.

The moisture contents of the samples were then combined with the weight of the contributing component, or components, to calculate the moisture content of the residential solid waste as shown below.[a,b]

$$2/26/69 \quad M.C. = \frac{(0.294)\ (4.5 + 22.5 + 36.0 + 3.5) + 0.080\ (6.0) + 0.070\ (3.0) + 0.0\ (152.0)}{227.5}$$

$$M.C. = \frac{19.6 + 0.5 + 0.2}{227.5} = \frac{20.3}{227.5} = 0.089 = 8.9\%$$

$$2/28/69 \quad M.C. = \frac{0.617\ (17.0) + 0.165\ (6.0) + 0.232\ (31.5) + 0.329\ (4.5) + 0.080\ (1.5) + 0.070\ (5.0)}{180.5}$$

$$M.C. = \frac{20.7}{180.5} = 0.115 = 11.5\%$$

$$3/4/69 \quad M.C. = \frac{0.594\ (36.0) + 0.567\ (46.0) + 0.299\ (45.0) + 0.090\ (25.0) + 0.080\ (7.0) + 0.070\ (3.5)}{264.0}$$

$$M.C. = \frac{64.0}{264.0} = 0.242 = 24.2\%$$

TABLE D-1

SOLID WASTE MOISTURE-CONTENT DETERMINATION,

TERRITORY OF GUAM,

FEBRUARY 26, 1969, TO MARCH 5, 1969

Type of sample and date collected	Sample dish tare wt. (gm)	Wet wt. of sample and dish	Dry wt. of sample and dish	Wet wt. of sample	Dry wt. of sample	Weight loss	% Moisture in sample (wet wt)
2-2-69							
Wet sample No. 1	356.1	437.1	408.0	81.0	51.9	29.1	35.9
Wet sample No. 2	356.7	431.2	414.0	74.5	57.3	17.2	23.0
Average	356.4	434.1	411.0	77.7	54.6	23.1	29.4
2-28-69							
Food	357.0	511.2	416.0	154.2	59.0	95.2	61.7
Garden	712.3	754.7	747.7	42.4	35.4	7.0	16.5
Paper	356.1	383.2	379.0	18.1	13.9	4.2	23.2
Textiles	356.4	401.3	386.5	44.9	30.1	14.8	32.9
3-4-69							
Food	356.3	480.0	406.5	123.7	50.2	73.5	59.4
Garden	357.0	398.6	375.0	41.6	18.0	23.6	56.7
Paper	356.9	384.6	376.3	27.7	19.4	8.3	29.9
Textiles	357.1	387.9	385.1	30.8	28.0	2.8	9.0
3-5-69							
Food	356.1	503.5	402.0	147.4	45.9	101.5	68.8
Garden	356.4	440.3	412.0	83.9	55.6	28.3	33.7
Paper	356.2	393.4	386.1	37.2	29.9	7.3	19.6
Textiles	357.0	437.7	406.5	80.7	49.5	31.2	38.6

3/5/69 $$M.C. = \frac{0.688\ (20.5) + 0.337\ (22.0) + 0.196\ (29.5) + 0.386\ (14.5) + 0.080\ (2.5) + 0.070\ (7.0)}{198.5}$$

$$M.C. = \frac{33.6}{198.5} = 0.169 = 16.9\%$$

Average moisture content = 0.154 = 15.4%

REFERENCES

a. Kaiser, E. R. Chemical analyses of refuse components. In Proceedings; 1966 National Incinerator Conference. New York, American Society of Mechanical Engineers, 1966. p. 84-88.

b. Fryling, G. F. Combustion Engineering. New York, Combustion Engineering, Inc., 1966. [883 p.]

APPENDIX E

EFFECT OF RAINFALL ON MOISTURE CONTENT OF SOLID WASTE

Solid waste stored in open containers (the common practice on Guam) will absorb water in relation to the amount of rain that falls on it up to the moisture-holding capacity of the waste. (Most of the containers on Guam have perforated bottoms and will not therefore retain more water than the holding capacity of the waste.) Previous studies[a] have shown that this moisture-holding capacity is about 213 percent on a dry basis or 68 percent on a wet basis.

Residential waste on Guam had a density of 4.9 lb per cu ft with a moisture content of 15.4 percent (wet-weight). The corresponding dry density would be 4.1 lb per cu ft.

If we assume that a typical container has a diameter of "D" feet, its base area will be $\pi D^2/4$. Rainfall will enter the container in the total volume of $\pi D^2 R/48$ cu ft, where R is the amount of rain in inches. The weight of the rain will be $62.4\ \pi D^2 R/48$ lb.

The moisture content of the waste on a dry basis would then be:

$$\text{Moisture content (\% dry)} = \frac{\text{pounds of rain + pounds of natural moisture}}{\text{pounds of dry waste}} \times 100$$

The average volume of waste in each container surveyed on Guam was found to be 4.0 cu ft, which is equivalent to a dry weight of waste of 16.4 lb per container.

An analysis of separation data for Guam and reported moisture content of components under laboratory conditions[b,c] indicates that the lowest expected moisture content would be 11.5 percent on a wet basis, or 130 percent on a dry basis. Natural moisture, at 13.0 percent of dry weight, would be 2.2 lb per container.

The 55-gal drums encountered on Guam had an average diameter of 1.85 ft. The weight of rain entering these containers would then be equal to 14.0 R lb, where R is the amount of rain in inches.

Expressed as a function of rainfall, the dry weight moisture content of the residential waste on Guam would be:

$$\text{Moisture content } (\%) = \frac{14.0\ R + 2.2}{16.4} \times 100$$

$$= 85.4\ R + 13$$

The average monthly rainfall for Guam is shown on Table E-1.

Using the developed equation, the relationship between rainfall and the moisture content of the waste (Figure E-1) was calculated by assuming that one-quarter of the monthly rainfall would fall during the 7 days between collections.

The total weight of the waste is the sum of dry weight and the weight of the moisture in it. As the moisture content increases, the unit weight of the waste will also increase according to the following relationship:

Unit weight (wet basis) = dry weight + weight of water

= dry weight + (dry weight) × (fraction of water)

= (dry weight) × (1 + fraction of water)

The dry unit weight of waste on Guam was found to be 4.1 lb per cu ft. Substituting this figure into the above equation the following is obtained:

Unit weight (wet basis) = 4.1 (1 + fraction of water)

This relationship was then used to calculate the unit weight of waste for the expected moisture contents.

For the average moisture content of 140 percent, the unit weight of residential solid waste is about 9.8 lb per cu ft.

Although an analysis of this type is not as good an engineering practice as more frequent sampling of the waste, it is felt that this will yield conservative results that can be used in a report of this type to estimate the magnitude of the solid waste problem on Guam. Additional sampling during both wet and dry seasons should be conducted before detailed plans for solid waste management are designed and implemented.

TABLE E-1

AVERAGE RAINFALL AT AGANA NAVAL AIR STATION, GUAM, 1952-62
(Inches)

Month	Average monthly rainfall*	Assumed average weekly rainfall
January	3.85	0.96
February	2.73	0.68
March	1.90	0.47
April	2.87	0.71
May	3.68	0.92
June	4.48	1.12
July	9.10	2.27
August	12.68	3.17
September	14.71	3.67
October	13.06	3.26
November	10.18	2.54
December	5.46	1.36

*Data from Ward, P.E., S.H. Hoffard, and D.A. Davis. Hydrology of Guam. Geological Survey Professional Paper 403-H. Washington, U.S. Government Printing Office, 1965. 28 p.

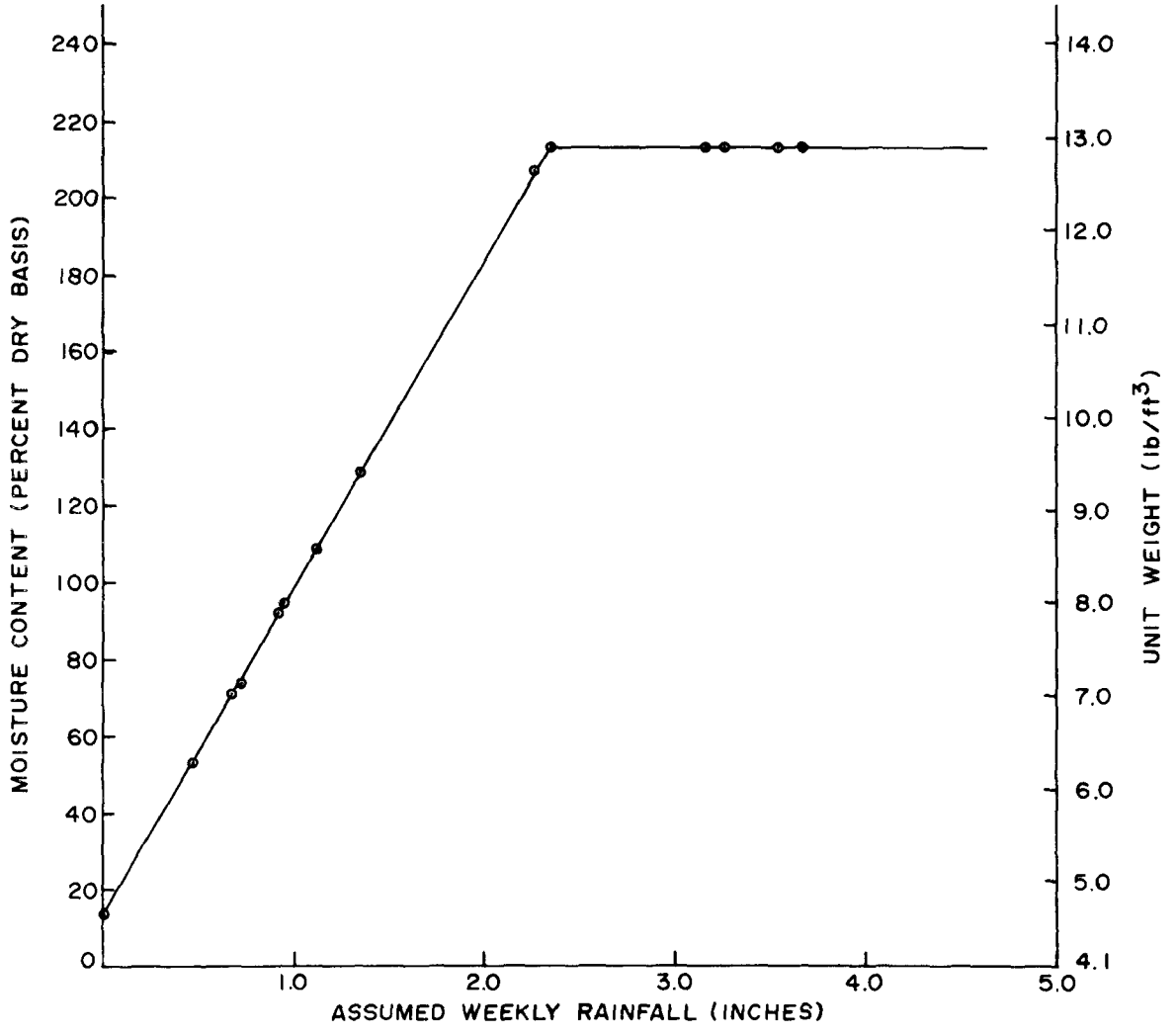

Figure E-1. Relation between rainfall, moisture content, and unit weight of solid waste.

REFERENCES

a. Solid wastes landfill stabilization; second annual report. Los Angeles, Ralph Stone and Co., Inc., 1969. mimeo. 147 p.

b. Kaiser, E. R. Chemical analyses of refuse components. In Proceedings; 1966 National Incinerator Conference, New York, May 1-4, 1966. American Society of Mechanical Engineers. p. 84-88.

c. Fryling, G. F. Combustion engineering. New York, Combustion Engineering, Inc., 1966. [883 p.]

APPENDIX F

COLLECTION TIMES AND TIME-STUDY PROCEDURE

Seven of the solid waste collection trucks were followed during the study to tabulate the number of miles traveled, services and items collected, and the amount of time necessary for collection (Figure F-1).

Rather than collecting information on a total trip basis, data were recorded for short distance intervals, either a block or a similar distance. This practice resulted in a number of data points that were applicable to evaluation by multiple regression.

The last four columns in Figure F-1 were used for work sampling of the collection process. Fifty randomly spaced observations were made of each of the three crew members over a 2½ hr period. At the time of observation it was recorded if the crew member was walking, carrying, loading, riding, waiting, or doing some other operation. The total number of observations of walking, carrying, loading, and riding was divided by the total number of observations (150) to obtain the fraction of productive time for a particular crew. Similarly, the fraction of "waiting" time and of "other" time was also calculated.

The elapsed time for each data point recorded in the field was then multiplied by the productive fraction to obtain the productive time. This operation was carried out to reduce the variation between crews so that the data from similar vehicles could be combined for analysis.

Multiple regressions were run of distance, number of services, and number of items against productive time. The distance from the truck to the items for collection was not included because of the lack of variation in the data. These regressions were first run for each individual truck; the data for packer trucks and for dump trucks were then combined into two groups. The resulting equations for these two types of vehicles are:

Packer: Productive time = 2.84 × (miles) + 0.09 × (No. of services) + 0.21 × (No. of items) + 0.38

Dump: Productive time = 8.63 × (miles) - 1.29 × (No. of services) + 1.40 × (No. of items) + 0.99

Residential Collection Data Sheet

Page___A of___

City_____ Date_____
Route_____ Weather_____
Vehicle No._____ Data by_____
Type_____ _____
Capacity_____cy

S = walking_____ for_____ %
C = carrying_____ for_____ %
L = loading_____ for_____ %
R = riding_____ for_____ %
W = waiting_____ for_____ %
O = other_____ for_____ %

No.	Location	Distance (feet)	Elapsed Time	Number of Services	Number of Items	Avg Distance to Items(Ft.)	Time (O =)	Man One	Man Two	Man Three

Figure F-1. Field survey collection-time data sheet.

The equation for packer trucks explained 88 percent of the variation in the data with a standard deviation of 23 percent of the response mean. Eighty-six percent of the variation was explained for dump trucks with a standard deviation of 24 percent of the response mean.

Although the "waiting" time was removed for the purpose of analysis, it is a function of the equipment used and the skill of the crew and will always be present to some degree. It must therefore be considered when calculating the total collection time.

Similarly, the "other" time will always be present because a crew cannot be expected to work 8 hr without breaks or rest periods. The "waiting" and "other" times were added to the calculated productive time to get the collection time--1.64 times the productive time for packers and 1.45 times the productive time for dump trucks.

APPENDIX G

EQUIPMENT NEEDS

Assume that twice weekly collection of waste will be provided for residences, businesses, industries, and labor camps, and daily collection for schools, hospitals, and government offices. There are 12,693 residential dwelling units that must be collected twice weekly, thus making a total of 25,386 services. The daily collection (5 days per week) would include 5,080 residences. With an average of 1.82 items per service, this would be 9,240 items per day.

There are 547 commercial establishments, 13 hotels, 32 parks, 15 industries, 27 clinics, 16 alien labor camps, and 58 churches that must be collected twice weekly for a total of 1,416 services or 280 units per day. With three items per service, this is 840 items per day.

There are 40 government offices on the island, 65 schools, and one hospital. Assume that there are 10 items at each of these services; the result is 106 services and 1,060 items per day.

This is a total of 5,466 services and 11,140 items per day. If there are 60 services per mile, daily collection will cover about 90 miles. By making use of the equation for packer trucks presented in Appendix F, the following results:

$$\text{Productive time} = 2.84\ (\text{miles}) + 0.09\ (\text{No. of services}) + 0.21\ (\text{No. of items}) + 0.38$$

$$= 2.84\ (90) + 0.09\ (5{,}466) + 0.21\ (11{,}140) + 0.38$$

$$= 256 + 492 + 2{,}339$$

$$= 3{,}087 \text{ min}$$

The total daily collection time is therefore:

$$\text{Collection time} = 1.64\ (\text{productive time})$$

$$\text{Collection time} = 1.64\ (3{,}087) = 5{,}063 \text{ min} = 84 \text{ hr}$$

We must further assume that, of the 8-hr collection day, 2 hr are spent traveling to and from the route and disposal site and at the disposal site. This leaves 6 hr for collection. The number of necessary packer trucks is then:

Number of trucks = total collection time ÷ collection time per truck

= 84 ÷ 6 = 14 trucks

It has been shown that a change to 32-gal containers and the elimination of 55-gal drums would result in a time savings of 22 percent. If this savings is applied to the time associated with the number of items (2,339), the productive time would then be:

Productive time = 256 + 492 + 0.78 (2,339)

= 748 + 1,824 = 2,572 min

Collection time = 1.64 (2,572)

= 4,218 min = 70 hr

Number of trucks = 70 ÷ 6 = 12 trucks

Further time savings could be achieved by the use of disposable bags (either plastic or paper) and bulk containers at sources with large numbers of cans. Other factors should be examined, however, before adoption of these systems. These include the use of special collection equipment, cleaning of containers for the bulk container system, the cost of bags, racks, and animal-attraction problems associated with bag storage of solid waste.

APPENDIX H

PRESENT LEGISLATION*

SUBCHAPTER Q

Garbage and Rubbish

§9660. Definitions. The following definitions shall apply in the interpretation and enforcement of this chapter:

(a) "Garbage" means any offal, swill, leavings of food abandoned, spoiled, condemned, or decayed meat, fish, animal, or vegetable matter, including offal from the slaughtering of animals.

(b) "Rubbish" means any waste, refuse, broken or rejected matter, trash, junk, debris, not including garbage, whether combustible or noncombustible.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

*Reprinted from the Government Code of Guam.

§9660.1. Prohibition. No person shall have on his premises any garbage or rubbish except as herein provided.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.2. Garbage on Premises. Garbage shall be stored in durable, metal receptacles which shall have close-fitting covers. Such receptacles shall be kept covered except while being filled or emptied.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.3. Rubbish on Premises. Rubbish shall be stored in durable receptacles with close-fitting covers, except that bulky rubbish such as branches, weeds, or boxes may be bundled.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.4. Edible Garbage. The Director is authorized to prescribe by regulation such processing and limitations with respect to the use of garbage as animal feed or other use as he may deem necessary for the public health. No garbage shall be sold or disposed of as food for human consumption.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.5. Removal of Construction Debris. Removal of rubbish, debris, and earth incident to construction or excavation work, or grading of land, shall be the responsibility of the owner of the building or land.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.6. Disposition. No person shall dispose of any garbage, rubbish, or other offensive substances, including dead animals and offal, into any river, creek, pond, reservoir, stream, well, or spring,

or any collection of fresh water, into or upon any public or private driveway, alley, street, highway or road, beach, or any public place, or any public property except in an authorized public dump or receptacle furnished for such purpose, or other place as may be authorized by the Director, or on any other private property except with the consent of the owner and in conformity with law.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.7. Burning Garbage. No person shall destroy or attempt to destroy by burning, except in an incinerator the construction and operation of which is approved by the Director, or as may otherwise be authorized by the Director, any garbage, dead animals, or other offensive substances the burning of which may give off foul and noisome odors, in, or within one fourth (¼) mile, of Agana, any village, or any other urban area.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.8. Department of Public Works to Collect. The Department of Public Works shall collect and dispose of garbage and rubbish, except where the Governor, by executive order, places this responsibility upon a Commissioner. Such collection and disposal service shall be furnished in Agana and all villages and urban area, and may be extended to further areas by administrative action. No fee or assessment shall be levied or charged for the collection and disposal of such garbage and rubbish from premises or portion of premises used exclusively for residential purposes. As to all other premises, fees shall be charged. The Director of Public Works shall establish a schedule of reasonable fees and a procedure for payment thereof by regulation.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.9. Transportation. No person shall transport any garbage or rubbish in any vehicle in any street or highway unless adequate precautions are taken to prevent such garbage or rubbish from falling from or being dislodged from such vehicle during such transportation. If any such garbage or rubbish falls from or is dislodged from any

such vehicle upon any street, highway, or any other public or private property, it shall be the obligation of the operator of such vehicle immediately to pick up and remove such garbage or rubbish.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.10. Vehicles Not to be Used for Food Transportation. Vehicles used for conveying garbage or rubbish shall not be used for the transportation or conveyance of any food or drink, including any meat, fish, vegetables, or other food stuff which are to be used for human consumption.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.11. Regulations. The Director of Public Works may by regulation prescribe additional requirements with regard to garbage and rubbish receptacles and collection of garbage and rubbish.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.12. Director to Supervise Sanitation of Dumps. The Director shall have cognizance for health and sanitation purposes of all public and private dumps or sites used for the dumping, incineration, or other disposition of garbage, rubbish, and other offensive substances. He may in his discretion order that any such dump or site be closed, abandoned, filled in, or otherwise terminated, in whole or in part, or limited in its operations, in the interests of the public health.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.13. Acquisition of Property for Dump Purposes. In accordance with provisions of law such public land may be set aside or acquired as may be needed as public dumps or sites for the dumping, incineration or other disposition of garbage, rubbish and other offensive substances. No such land shall be set aside or acquired for such purpose without the prior approval of the Director.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.14. Operation of Dumps. Public dumps shall be established, operated and maintained by the Department of Public Works, except where the Governor, by executive order, places this responsibility upon a Commissioner.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.15. Contract. The Department of Public Works, with the approval of the Governor, may execute a contract after public bid with a private person for the collection and disposal of any garbage, rubbish, or other offensive substances, or separate items thereof.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)

§9660.16. Persons Prohibited from Dumps. No person shall be permitted on any public dump except persons having material to dump and other authorized persons.

(Added by P.L. 109, 3rd G.L., approved August 13, 1956, to be effective at 12:01 A.M. on the sixtieth day following its approval.)