# APPENDIX F

## ESTIMATION TECHNIQUES

An accurate estimation of the quantities of solid waste materials is fundamental to all aspects of solid waste management. Planning in collection, landfill, incineration, or resource recovery demands accurate estimates of the materials available. The techniques outlined here provide varying degrees of accuracy. The more precise the estimate must be, the more it will cost to obtain.

APPENDIX F

ESTIMATION TECHNIQUES

SOLID WASTE SURVEY PLANS

## 1. **Introduction**

The following plans are excerpts from the Logistics Management Institute Report, Measurement and Description of the DoD Solid Waste Problem, Project 8 (Interim Report) of March 1976, selected to familiarize the users of this document with four methods of accomplishing a solid waste survey: Plan A, Low Cost/Low Precision - No Measurement Study; Plan B, Low Cost/Low Precision Survey; Plan C, Medium Cost/Medium Precision Survey; and Plan D, High Cost/High Precision Survey.

Plan A uses information readily available on the installation or from published sources. It requires no field measurements and a minimum of expense. Plan B encompasses Plan A as a reference base, but requires measurements of solid waste weights on each of 15 collection days and visual estimates of the composition and container load-volume percentages. It is a low-cost plan because it utilizes collection personnel to record the data. Plan C also encompasses Plan A. A sampling schedule, which identifies individual or groups of similar waste-generating facilities, is constructed and implemented by a survey team for 20 collection-day measurements. Composition is determined by hand segregation and weight measurements. Plan C provides a higher level of waste measurement and is more expensive to conduct than Plan B. Plan D is similar to Plan C but the survey is conducted over four 20-day measurement periods with each 20-day measurement period taking place in a different quarter of the year.

## 2. **Low Cost/Low Precision - No Measurement Study (Plan A)**

a. Time Series Analysis, Step 1. Collect recorded monthly weight, container trips, or container load volumes of the solid waste disposed in the landfill or incinerator, plus the weight of scrap materials turned into the Defense Reutilization and Marketing Officer (DRMO), for the three most recent fiscal years. Determine if the data constitute a time series; if so, determine the secular trend and develop the seasonal index. Convert all container trip data to tons using a density factor of 82 pounds per cubic yard. If the loose-cubic-yard volume has already been adjusted for percent load (i.e., container 100, 75, 50, or 25 percent filled), convert to tons using a density factor of 180 pounds per cubic yard. Use the calculated trend and seasonal index of the time series analysis to forecast the monthly and yearly total of the solid waste tonnage for the current year. Use the trend to forecast the yearly totals for the next four fiscal years. Record, by month, the total weight and type of solid waste recovered through sales by the DRMO or volunteer efforts.

b. **Emission Variable Analysis**

(1) Step 2. Itemize the major solid waste generating facilities (or groups of facilities) and collect population, square footage, and

other pertinent emission variable data. Construct similar tables for each year of interest. For future years the estimates of the variables are restricted to the major categories of Family Housing, Troop Support, Industrial Activities, and Total Installation.

(2) Step 3. Using the average emission factor values of Table F-I and the models of Table F-2, calculate estimates of the solid waste generated.

(3) Step 4. Compare the total solid waste weights calculated in Steps 1 and 3. If there is wide variation between the estimated weights for the most recent year of recorded data, adjust the emission factor estimates of Step 3 to close agreement with the weights determined by Step 1. The Step 1 weight is based upon volume measurements of the particular installation, while the emission factor estimates were derived from composite measurements of other installations. Once adjusted, the Step 3 estimates, which reflect the installation's activity levels, shall be used to forecast the solid waste of future years.

(4) Step 5. The weights derived through Step 4 can be converted to component values by multiplying the estimated installation weights by the pertinent composition percentages of Table F-3.

3. **Low Cost/Low Precision Survey (Plan B)**

Plan B consists of the no measurement" study of Plan A combined with a limited (15-day) waste source survey. Approximately 90 percent of the staffing will be composed of supervisory personnel (GS-11 or equivalent). The 15 days of weight measurements will provide a quarterly estimate of the mean weight with a precision close to plus or minus 10 percent of the mean, with a confidence level of 0.8. It will not be possible to provide a confidence level of the composition estimates as they rely on visual approximations.

a. No-Measurement Analysis, Step 1. Complete the five-step analysis of Plan A. The estimates of the aggregate solid waste weight and component weights will be used as a reference base to afford comparisons with the measurement (weighed) values.

b. Limited Solid Waste Survey

(1) Step 2. The survey supervisor develops a system for identifying the collection vehicles and the solid waste generating sources (by building or groups of similar buildings). The survey supervisor, after consulation with collection personnel, constructs a collection and weighing schedule for each day of the two-week survey. Since the collection personnel will do all of the data recording, only minor modifications shall be made to the existing collection schedule. A protocol, covering the various steps of the solid waste survey, is constructed by the survey supervisor and explained to the collection personnel, along with instructions on filling out a collection card and weigh card.

TABLE F-1. Military Solid Waste Quantity Emission Factors by Facility Type

| Code | Waste Source | Pounds/1000 sq ft/day | | Pounds/employee-(resident)/day | | Other | | |
|---|---|---|---|---|---|---|---|---|
| | | USN | USAF | USN | USAF | USN | USAF | |
| | **Type 0 Waste** | | | | | | | |
| 610 | Office | 7.3 | 10 | 1.5 | 1.5 | | | |
| | Office | 17.8 | 7.4 | | 1.8 | | | |
| | Business | 39.4 | 8 | 11.1 | 4.3 | (600 | 20 | Pounds/$1000 sales/day) |
| 740 | Service Station | | 63 | | | | | |
| 171 | Classroom | 3.3 | 8 | 0.8 | 3.7 | | | |
| | Classroom | 3.3 | 3.3 | | | | | |
| 440 | Storehouse | 23.7 | 5 | 8.8 | 12.0 | | | |
| | Storehouse | 10 | | | | | | |
| 440 | Warehouse-Transfer | | 3.3 | | | | | |
| | Transfer & Pack | | 31 | | | | | |
| 210 | Maintenance | 13.2 | 2 | 5.4 | 1.6 | | | |
| | Maintenance | 15.6 | | | | | | |
| | Jet Engine Shop | | 4.8 | | | | | |
| | Electronic Shop | | 8.2 | | 1.7 | | | |
| | Machine Shop | | 7.4 | | 2.4 | | | |
| | Aircraft | | 17.5 | | | | | |
| 220 | Production | 22 | | | | | | |
| | Munitions - General | | 21 | | 4.4 | | | |
| 740 | Community Facilities | | 9 | | 12.5 | | | |
| | Community Facilities | | 4.7 | | | | | |
| | Field House | | 20 | | | | | |
| 141 | Operational | 15 | | | | | | |
| 150 | Piers & Wharves | 150 | | 5.1 | | | | |
| 310 | R&D | 3.3 | | | | | | |
| | **Type 1 Waste** | | | | | | | |
| 740 | Commissary | 63 | 121 | 20.4 | 10.1 | (90 | 80 | Pounds/$1000 sales/day) |
| | Commissary | | 74 | | | | | |
| | Exchange | | 200 | | | | | |
| 510 | Hospital | 9 | 12 | 1.9 | 2.5 | | (2.6 | Pounds/meal/day) |
| | Hospital | 9 | 12 | | | | | |
| 540 | Dental Clinic | 9 | | | | | | |
| 550 | Dispensary | | 9.1 | | 1.9 | | | |
| 720 | Barracks (No Mess) | | 4 | 0.31 | 0.8 | | | |
| | Barracks (No Mess) | 1.7 | 4 | | 0.3 | | | |
| | **Type 2 Waste** | | | | | | | |
| 710 | Family Housing | 10 | 10 | 3.5 | | | (3.3 | Pounds/capita/day EPA) |
| 723 | Bachelor Housing | 7 | | | | | | |
| 730 | Stockade | | 5.3 | | | | | |
| | **Type 3 Waste** | | | | | | | |
| 722 | Mess Hall | 74.7 | 60 | 22.8 | 30 | (0.6 | 0.92 | Pounds/meal/day) |
| | Mess Hall | | 60 | | | | | |
| 740 | Clubs | 20.3 | 60 | 5.85 | 30 | (1.2 | | Pounds/meal/day) |
| | Officer | 14 | | | | | | |
| | CPO | 42.7 | | | | | | |
| | Aggregate Installations | | | | | (4.6 - 9.3 | | Pounds/capita/day) |

TABLE F-2. Models of Solid Waste Generation Rates Based on Military Facility Emission Variables

| Code | Waste Source Generation Rate in Pounds/Day | Emission Variables | R* | F# | No. Observ. | Comments |
|---|---|---|---|---|---|---|
| | **Type 0 Waste** | | | | | |
| 610 | Administrative Building | 66 + 0.01 (No. Employees) | 0.55 | 16.0 | 15 | Category may be too broad; "Square Footage" variable N.S.; low R |
| 440 | Storage-Covered | 434 + 0.0 (No. Employees) - 3.1 (1000's square feet) | 0.75 | 33.4 | 25 | "Sq. Ft." variable sign negative; data includes a commissary |
| 210 | Maintenance | 200 + 2.1 (No. Employees) | 0.62 | 15.1 | 16 | "Sq. Ft." variable N.S.; dummy variable for Navy vs. Air Force facility N.S. |
| | **Type 1 Waste** | | | | | |
| 740 | Commissary | -1292 + 53 (1000's Square Feet) + 74 (1000's $ Sales/Day) | 0.97 | 56.4 | 6 | Three degrees of freedom; negative constant term; "No. Employees" variable N.S. |
| 740 | Main Exchange | -784 + 15 (No. Employees) | 0.997 | 302 | 3 | One degree of freedom; negative constant term |
| 610 | Hospital | -1065 + 25 (1000's Square Feet) | 0.93 | 64.7 | 7 | "Meals Served/Day" and No. Beds" variables N.S.; negative constant term |
| 720 | Bachelor Housing | 12 + 0.52 (No. Residents) | 0.64 | 15.0 | 11 | "Sq. Ft." variable N.S.; grade structure not measured |
| | **Type 3 Waste** | | | | | |
| 720 | Mess Halls | -00 + 1.2 (Meals Served/Day) | 0.95 | 00.1 | 7 | "Sq. Ft." variable N.S.; negative constant term |
| | **Type 1-3 Waste (Non-Military)** | | | | | |
| | Clothing, Hardware and Restaurants (Pounds/Week) | -197.29 + 5.20 (No. Hours Open/Week) + 19.30 (No. Employees) | 0.70 | -- | 01 | 01 observations of 32 stores summer of 1967; dummy variables for Clothing, Hardware, and Restaurants N.S.; emission variables "No. Business Days Open/Week," "Average Annual Gross Receipts," "Square Footage," "Average Inventory $," "Equipment Value in $," and "No. Delivery Days/Week," N.S. |
| | Drug Stores (Pounds/Week) | -349.25 + 5.20 (No. Hours Open/Week) + 19.30 (No. Employees) | | | | |
| | Grocery Stores (Pounds/Week) | 31.40 + 5.20 (No. Hours Open/Week) + 19.30 (No. Employees) | | | | |

* A correlation coefficient which is a measure of the fit of the mathematical expression to the observed data. R is a number between 0 and 1. If R=1 the fit is "perfect."

test statistic which is a frequency distribution of a ratio of the ... es of two populations. Its computed value when compared ... standard statistical tables, gives another measure of how appropria... mathematical model is for describing the real observations.

## TABLE F-3
## Composition of Solid Waste by Weight Percentage

| MIL. SER. | | PAPER | CARDBOARD | SUBTOTAL PAPER | WOOD | VEGETATION | PLASTIC | RUBBER/LEATHER | TEXTILES | FOOD WASTE | FERROUS METALS | NON-FERROUS METALS | SUBTOTAL METALS | GLASS/CERAMICS | INERTS AND MISC. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | TYPE O WASTE | | | | | | | | |
| N | OFFICE | | | 87 | 3 | 11 | 2 | 4 | 1 | 4 | | | 6 | 1 | 3 |
| N | BUSINESS | | | 83 | 6 | | 3 | | | 5 | | | 2 | | 1 |
| A | ADMINISTRATIVE | 70 | 2 | 72 | | | 3 | | 1 | 10 | | | 8 | 3 | 3 |
| A | ADMINISTRATIVE | 43 | 16 | 59 | | 10 | 8 | | 1 | 6 | 6 | 2 | 8 | 8 | |
| N | CLASSROOM | | | 68 | 6 | 4 | 3 | 1 | 1 | 3 | | | 6 | | 7 |
| N | STOREHOUSE | | | 57 | 22 | | 2 | 1 | 1 | 2 | | | 2 | 2 | 11 |
| N | MAINTENANCE | | | 55 | 11 | 2 | 2 | 9 | 4 | | | | 6 | 1 | 10 |
| A | WAREHOUSE | 23 | 52 | 75 | | | 12 | | 2 | 3 | 4 | 1 | 5 | 1 | 2 |
| A | INDUSTRIAL | 14 | 22 | 36 | 31 | | 6 | | 4 | | 19 | | 19 | 4 | |
| A | INDUSTRIAL | 15 | 16 | 31 | | | 10 | 1 | 9 | 2 | | | 13 | 8 | 28 |
| A | RECREATIONAL | 27 | 31 | 58 | | 1 | 7 | | 4 | 9 | 19 | 4 | 13 | 8 | |
| A | OFFICES, SCHOOLS | | | 58 | | 15 | 2 | 3 | 2 | 5 | 8 | 1 | 9 | 5 | |
| | | | | | | | TYPE 1 WASTE | | | | | | | | |
| N | COMMISSARY | | | 85 | 6 | | 2 | | | 5 | | | 2 | | 1 |
| A | COMMISSARY | 11 | 61 | 72 | 14 | | 2 | | | 8 | | | | 1 | 3 |
| A | COMMISSARY | | | 58 | | 23 | 4 | | | 8 | 7 | | 7 | 1 | |
| A | EXCHANGE | 8 | 62 | 70 | | | 4 | | | 12 | 4 | | 4 | 6 | 3 |
| N | HOSPITAL | | | 78 | 1 | 5 | 6 | | 2 | | | | 1 | 2 | 5 |
| N | LAUNDRY | | | 81 | | | 3 | 3 | | | | | 5 | | 8 |
| N | BARRACKS (NO MESS) | | | 54 | 4 | 11 | 2 | 2 | 1 | 17 | | | 7 | 1 | 2 |
| A | QUARTERS (NO MESS) | 29 | 22 | 51 | 1 | | 5 | | 1 | 5 | 13 | 2 | 15 | 16 | 6 |
| AF | E.M. HOUSING | | | 47 | | 7 | 3 | | 8 | 7 | | | 12 | 14 | |
| | | | | | | | TYPE 2 WASTE | | | | | | | | |
| A | FAMILY HOUSING | 29 | 7 | 36 | | 20 | 4 | | 1 | 15 | 5 | 2 | 7 | 9 | 9 |
| A | FAMILY HOUSING | 42 | 2 | 44 | | | 4 | | 3 | 19 | | | 11 | 13 | 6 |
| A | FAMILY HOUSING | | | 57 | | 10 | 1 | 3 | 5 | 5 | 9 | 2 | 11 | 9 | |
| AF | FAMILY HOUSING | 63 | 6 | 69 | | 6 | 7 | | 6 | 2 | 6 | 1 | 7 | 2 | |
| AF | NCO & OFCR. QUARTERS | | | 56 | | 4 | 4 | | 6 | 11 | | | 9 | 8 | 3 |
| | | | | | | | TYPE 3 WASTE | | | | | | | | |
| N | MESS HALL | | | 62 | | 9 | 4 | | | 18 | | | 6 | | 2 |
| A | MESS HALL | | | 49 | | 21 | 1 | 1 | | 7 | 13 | 1 | 14 | 6 | |
| A | DINING | 11 | 18 | 29 | | | 6 | | 1 | 43 | 10 | | 10 | 8 | 1 |
| A | DINING (EXCLUDING SOLD GARBAGE) | 17 | 26 | 43 | | | 9 | | 3 | 17 | 14 | | 14 | 12 | 1 |
| N | CLUB | | | 46 | 9 | 2 | 3 | | 4 | 21 | | | 5 | 12 | 3 |
| A | CLUB | | | 27 | | 29 | 1 | | 1 | 5 | 8 | 1 | 9 | 29 | |
| | | | | | | | TYPE 0-3 WASTE | | | | | | | | |
| A | INSTALLATION | 28 | 19 | 47 | 1 | 9 | 6 | | 1 | 11 | 7 | 1 | 8 | 9 | 7 |
| A | INSTALLATION | | | 56 | | 14 | 2 | 2 | 3 | 5 | 9 | 1 | 10 | 7 | |
| AF | INSTALLATION | 34 | 14 | 48 | 3 | 6 | 4 | | 3 | 12 | 8 | | 8 | 2 | 17 |
| AF | INSTALLATION | | | 58 | 7 | 4 | 4 | | 2 | 8 | | | 10 | 3 | 2 |
| N | INSTALLATION | | | 57 | 17 | | 9 | | 5 | | | | 8 | | 3 |
| | | | | | | | MUNICIPAL SOLID WASTE NATIONAL AVERAGE, 1968 | | | | | | | | |
| | MUNICIPAL (MOIST BASIS) | | | 43 | 3 | 12 | 2 | 1 | 3 | 13 | | | 9 | 9 | 7 |
| | MOISTURE CONTENT | | | 20 | 15 | 49 | 12 | 7 | 20 | 49 | | | 5 | 2 | 5 |
| | ADJ. MUNICIPAL (DRY BASIS) | | | 44 | 3 | 8 | 2 | 1 | 3 | 3 | | | 11 | 12 | 8 |
| | | | | | | | MUNICIPAL SOLID WASTE GENERATION BY MATERIAL AND SOURCE, 1971 | | | | | | | | |
| | MUNICIPAL (AS GENERATED) | 19 | 12 | 31 | 4 | 19 | 3 | 3 | 1 | 18 | 9 | 1 | 10 | 10 | 1 |
| | MUNICIPAL (AS DISPOSED) | 23 | 15 | 38 | 4 | 15 | 4 | 3 | 2 | 14 | | | 10 | | 2 |

(2) Step 3. A collection card is filled out by the truck driver for each refuse container collected during a collection run.

(a) Date -- month, day and year.

(b) Can Size -- circle volume units.

(c) Building Number -- according to method approved by survey supervisor.

(d) Truck Identification -- according to method approved by survey supervisor.

(e) Run Number -- circle number which corresponds to the load of the day.

(f) Load Type -- circle number which corresponds to the predominant refuse type in the container; if none can be determined, circle mixed refuse. Unusual waste materials included in an otherwise homogeneous waste load shall be noted under the "other" category (e.g., motor block in a container full of wood scraps would be reported as a load type 2, 8-motor block).

(g) Load Volume -- circle number which best approximates the volume of waste in a container. The "no load" category is used only when investigating the waste production of a particular building or group of buildings. All conditions must be reported.

(h) Weather -- circle number which best describes the predominating weather for the run. Intermittent drizzle or snow flurries shall be reported as "dry."

(3) Step 4. A weigh card is filled out by the truck driver at the end of each trip to the landfill or incinerator. The survey supervisor will arrange for the scale operator to fill out similar weigh cards on all non-scheduled truck loads arriving at the landfill. The survey supervisor will collect information on truck capacities and composition ratios. Each collection truck driver will supply the following information on the weigh cards:

(a) Date -- month, day and year.

(b) Truck Identification -- according to the method approved by the survey supervisor.

(c) Run Number -- circle number which corresponds to the number of loads for that day.

(d) Loaded Weight -- the weigh master or truck scale operator will supply the loaded weight values to be entered in this blank.

(e) Load Type -- circle the numbers of the major components of the load and visually estimate the volume percentage of all load

types composing over 20 percent of the load. The mixed refuse category shall be used when no predominating load types can be identified.

(f) Load Volume -- circle the number which best approximates the volume of the load in the truck. "No bad" is used to record the empty weight of the truck and driver.

(g) Weather -- circle the number which best describes the predominating weather for the run. Intermittent drizzle or snow flurries shall be reported as "dry."

(h) After the weigh card is completed, the driver initials the bottom line and bands together that run's weigh card with the appropriate collection cards. At the end of the day, the driver turns in that day's information card bundles to his route supervisor who forwards the material to the survey supervisor.

b. Single Waste Stream Analysis, Step 5. Sort the collection cards by building number(s) and place them in chronological order. The loose yardage volume generated between collections is determined by multiplying the can size by the percentage of load volume. An approximate value of the collected weight is determined by multiplying the loose yardage volume by the appropriate bulk density values. Composition of the single waste stream is determined from the "Load Type" section on the collection card, or by using composition percentages. If a collection run is confined to a particular facility grouping (as family housing), the appropriate weigh card can be isolated and used to provide weight, volume and composition information.

c. Installation Total Waste.

(1) Step 6. The volume and weight estimates, derived from the analysis of the collection cards in Step 5, are summed over all the "single waste streams" to provide total weight and volume estimates on the collection points. Sum the net weights (loaded weight minus no load) from the weigh cards to arrive at the total collected weight. The loose yardage volume of each compactor truck is determined by multiplying the compactor's capacity by the load volume (percent) and the compaction ratio. Multiply non-compactor truck capacities by the load volume (percent). Sum the calculated volumes of all collection runs to determine the total volume. The bulk density of each collection run, or total installation waste, can be determined by dividing the net weight by the loose-cubic-yard volume. "Composition" information can be obtained from weigh cards by converting load type volumes to load type weights, and dividing by the sum of the adjusted refuse weights for all collection trucks. Load type weight is determined by multiplying load type volume by the appropriate load type bulk densities. Component weights of the solid waste materials can also be derived by multiplying the total weight by the installation composition percentages.

(2) Step 7. As a check on the survey operation, make preliminary calculations of the weights and volumes (as per Steps 5 and 6), using

data from the first two days of the survey, and compare the estimates derived independently from the collection cards, the weigh cards, and the no-measurement analysis of Plan A.

(3) Step 8. Revise the estimates of Plan A using the estimates derived from the two-week, limited solid-waste survey and present the historical and forecasted results.

4. **Medium Cost/Medium Precision Survey (Plan C)**

Plan C combines the no-measurement study of Plan A with a survey which entails 20 contiguous days of weight measurements of the installation's waste streams, and the physical segregation and weighing (for composition analysis) of three 100- to 200-pound samples of solid waste generated by each of the various facilities on the installation. Effective implementation of the Plan C survey shall result in an estimate of the installation's mean daily waste generating rate for the encompassing quarter with a 0.9 level of confidence and an error plus or minus 10 percent of the mean. Estimates for the year, or other periods outside the sample quarter, can be accomplished through revision of the Plan A estimates based on the weight measurements. Three 100-to 200-pound randomly selected samples from each solid waste emission source (building or group of similar buildings) shall provide estimates of the component proportions with at least 0.9 confidence levels and errors of plus or minus 10 to 30 percent of the fraction means.

a. No-measurement Analysis, Step 1. Repeat the steps of the "no-measurement" Plan A analysis described in Plan A, paragraph F.2.

b. Medium Cost/Medium Precision Survey.

(1) Step 2. The survey supervisor designs the survey and prepares an implementation protocol. To ensure coordination and control, the survey supervisor shall be located on the installation for the duration of the survey. The major tasks to be accomplished in the preparation of the protocol are as follows:

(a) Identify collection containers, waste generating sources (buildings), collection routes and disposal points on a map of the installation.

(b) Group the buildings and their containers by the major waste source categories (Family Housing, Troop Support, Industrial Activities) and subcategories.

(c) With the assistance of the collection supervisor, restructure the collection routes so that each truckload contains a single-source category of waste. Arrange for the return of each dumpster to its initial collection location. Set up a special collection team to collect the waste from those buildings which do not fall into a collection-run category.

(d) Designate a weighing station location (preferably at the main sanitary landfill) and instruct all facility managers that loaded solid waste trucks must have their loads and tare weights weighed and recorded by the survey truck-scale reader.

(e) Arrange for the special collection team to make daily stops to weigh the garbage at dining facilities with wet garbage contracts.

(f) Arrange for an enclosed space in which the composition team can segregate and weigh the composition samples.

(g) Arrange for the provision of necessary equipment:

- A pickup truck to collect plastic bags from designated buildings and the landfill. Note: If the contractor will not cooperate in collecting containers, a small dump truck will be required instead of a pickup.
- Portable, calibrated, truck scales (two each with 20,000-pound capacities).
- Bathroom scales (two) for weighing garbage at dining facilities.
- Plastic bags and tags for distribution by the special collection team.
- Two broad-mouth shovels and two rakes for mixing and quartering the refuse selected for composition analysis.
- Weighing scale for incinerator operators.
- Plastic bags and tags for transporting refuse from the landfill to the composition analysis location.
- Large table (6 x 4 feet) for composition analysis
- Fifteen 32-gallon containers for composition analysis.
- Weighing scale to weigh components (200-pound capacity).
- Broom, brush, and pan for cleanup after composition analysis.
- Liquid disinfectant detergent for cleaning up after composition analysis.
- Approximately six to ten pairs of reinforced neoprene gloves for sanitation purposes during composition analysis.
- Protective clothing (shoes, glasses and coveralls; four pairs each).

c. Weight and Volume Measurements, Step 3. Construct a daily schedule for the special collection team indicating which containers (including solid wet garbage) to weigh. If the weighing is accomplished by the team at the collection point, the data (excluding Load Type information) can be recorded on the collection cards. If the loaded truck is weighed, a weight sheet shall be used to record the data. All truckloads of solid waste traveling from the

installation facilities to final destinations must be weighed and measured for percent fillage, preferably at a central truck-scales location. The data shall be recorded on a weight sheet. It is assumed that each truckload of solid waste, as a result of Step 2 (b) and (c) can be identified with a particular installation building or grouping of similar buildings.

d. Composition Sampling.

(1) Step 4. Construct a daily schedule indicating which truck-loads, scheduled for disposal, are to be sampled for composition analysis. Truckloads to be sampled shall be randomly selected to ensure that each waste source stream (building or grouping of similar buildings) will have three 100- to 200-pound samples taken over the 20-day sampling period. The collection supervisor shall arrange to have the preselected truckloads delivered to the landfill (or point of sample collection) as soon as the regular daily collection runs begin. After each selected truckload is weighed at the truck-scales location, the load is dumped. The composition team rakes the pile to obtain an even distribution of the components and then subdivides the pile into 100- to 200-pound portions. A portion is randomly selected (using numbered slips drawn from a hat), bagged and tagged with proper identification. After the scheduled number of loads is sampled, the bags are brought to the segregation site. Each composition sample is then segregated by hand into component parts which are weighed. The data are recorded on composition sheets.

(2) Step 5. After two days of collecting weight, volume, and composition data, make preliminary calculations of the weights, volumes, and compositions of the facility waste streams and check these values against the estimates derived by the no-measurement analysis of Plan A (Step 1, paragraph F.2). Revise the survey procedure where necessary.

(3) Step 6. On completion of the 20-day survey, compile the recorded data, make the necessary calculations, and present the results.

(4) Step 7. Revise the monthly and yearly forecasts of Plan A using the estimates derived in Step 6.

5. **High Cost/High Precision Survey (Plan D)**

Plan D consists of the "no-measurement" study of Plan A, combined with the repeated application of the Plan C survey (20 contiguous days of weight, volume, and composition measurements) in each quarter of the year. Over a twelve-month period the installation's total waste stream, and the waste streams from the major solid waste generating sources (buildings or groups of buildings), will undergo 80 days of weight and volume measurements. Twelve 100- to 200-pound composition samples will be analyzed for each generating source. A survey of this scope shall result in estimates with errors less than plus or minus 10 percent of the mean weight with a 0.9 confidence level, for each quarter and the year. A similar level of precision shall hold for estimates of the solid waste components. The derived estimates can be used to determine the secular trend of the installation's waste-growth and a seasonal determine the secular trend of the installation's waste-growth and a seasonal index of the solid waste pattern. Factors for converting collection volumes to weights, and emission factors that associate solid waste generation rates

with facility activities (personnel levels, floor space, etc.) can be accurately determined. The goal of the survey is to enable the installation to construct models of its solid waste streams. The models can be used to forecast the levels of composition of future waste streams. The installation will, of course, be interested in the historical data on the solid waste operation, but, in making decisions on waste reduction and resource recovery, its primary interest will concern the future nature of the solid waste streams.

a. No-Measurement Analysis, Step 1. Complete the five-step analysis of Plan A (paragraph F.2). The no-measurement estimates of the activity solid waste streams and component weights will be used as a reference base to afford comparisons with the measured (weighed) values.

b. High Cost/High Precision Survey.

(1) Step 2. Perform Steps 2 through 7 of Plan C for the first quarter's survey. The four 20-day survey periods shall start approximately 91 days apart, but two of the survey periods shall be scheduled within, or bridging, months of high- and low-generation rates. If the seasonal pattern is expected to be different for the year surveyed, randomly select a starting month, and then schedule the remaining three 20-day survey periods to start every 91 days.

(2) Step 3. Repeat Step 2 for each of the remaining quarterly surveys. The protocol of Step 2 can be reused, with the exception that new schedules for composition sampling (Step 4 of Plan C) shall be constructed to avoid inadvertent bias.