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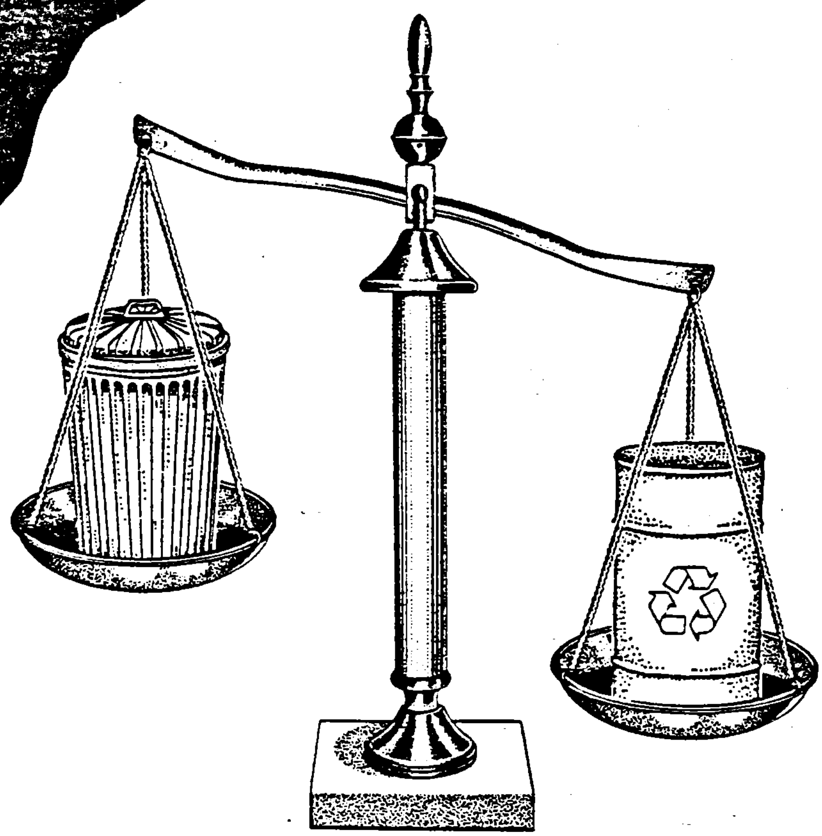
VARIABLE RATES IN SOLID WASTE
Handbook for Solid Waste Officials



VOLUME II - DETAILED MANUAL

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INTRODUCTION: DETERMINING RATES

The process of determining rates involves four basic steps. A schematic of the relationship between the steps appears in figure 1.

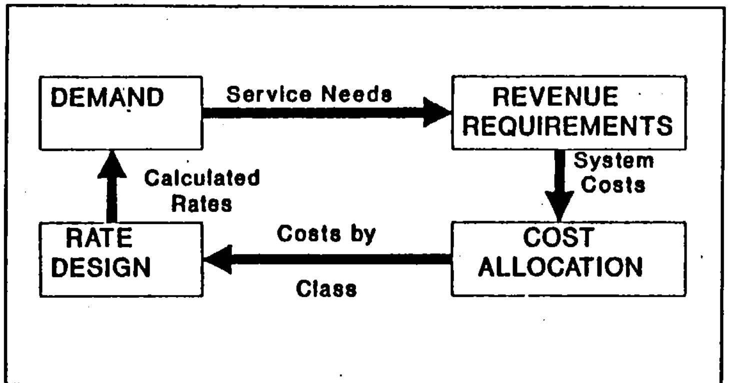

Figure 1

Module 1 - Demand: This step analyzes the demand for each type of service offered for each customer class. It generates estimates of the number of tons or cubic yards disposed[1] (by program or customer type), customer counts by type, and number of service units used (e.g., variable can subscription levels or bags/tags).

Because the demand module contains a great deal of information that is likely to be new to jurisdictions which do not use a volume-based rate system, the description of this module is fairly long and detailed.

[1] Some jurisdictions measure waste based on tonnages and others use measures of volume like cubic yards. To keep the wording of the discussions from getting awkward, a tonnage-based system is assumed. However, the discussions are directly applicable to systems that use volume measures like cubic yards.

Module 2 - Revenue Requirements: This step analyzes the costs that would be incurred meeting the demand for services estimated in the demand module. The revenue requirements module evaluates all the activities that would be required to provide the services on a cost-center basis. The module considers staffing and equipment requirements, production and cost relationships, and estimates the total costs. These, along with financial considerations, provide an estimate of the total amount of revenues that need to be collected from all sources, including rate and non-rate revenues.

Module 3 - Cost Allocation: This module analyzes how the revenue requirements calculated in Module 2 are to be distributed between and within customer classes. Relationships are developed that allow the jurisdiction to attribute the system's costs (or revenue requirements) based on the type of service delivered and the customer class served.

Module 4 - Rate Design: In this step, the form and relationships of the rates to be charged are determined. Then the module calculates the levels of rates that will recover the amount of revenues needed from each customer class and service type.

Equilibration: Going through these steps once will produce a set of rates, tons costs, revenues, and services. However, the rates that are calculated after one set of calculations are different from those used as the starting values, and will lead to changes in the forecast levels of demand. It will generally be necessary to re-run the model using the new estimated level of rates to re-estimate the level of tonnage and services that would be associated with the new rates. Rates (or prices) are expected to influence the amount of service that customers will demand. That new level of demand for services will lead to changes in the revenue requirements, cost allocation, and calculated rates.

Generally, the series of steps must be performed several times before the system reaches "equilibrium", or achieves a set of consistent answers that lead to only small changes when the modules are run again and the steps recalculate results.

Each of the modules will contain assumptions, relationships, and calculations that depend on the particular jurisdiction's situation. Because no two solid waste jurisdictions are alike, even in the basics like services, costs, and customer types, each rates model will be different. This section discusses some of the basic approaches and generic relationships, which must then be tailored to the particular jurisdiction being modelled.

ILLUSTRATION:

Module 1:	AnyTown projects that, charging its 100 residences an average of $80/year and self-haulers $5/load for 10,000 loads delivered to the landfill, it will handle 1000 tons/year.
Module 2:	Handling 1000 tons will require $150,000 of revenue.
Module 3:	Residences are responsible for $100,000 of expense; self-haulers for $50,000.
Module 4:	Residents' new rates set to average $100/year; self-haul rates left at $5.
Feedback:	Rates from Module 4 are used in Module 1; process continues until rates change very little on successive tries.

The complexity of the solid waste system determines the sophistication of the tools needed to complete the analysis. It is difficult to imagine that an integrated rate analysis can be done with a computer tool much simpler than LOTUS, and more complex computer tools such as SAS, GAUSS, or other systems may be needed for more sophisticated systems. The benefits of using languages such as these include flexibility to model alternative relationships and scenarios, being able to enhance the model over time, being able to integrate graphics, and being able to make the model more user friendly.

The following paragraphs explain each of these "modules" in more detail. Presumably, analyses similar to this are currently performed in generating solid waste charges, whether they take the form of actual rates, or tax assessments, or other charges. Therefore, the discussions below will highlight differences or changes that may be necessary with the implementation of variable rates. These changes will be concentrated in the demand and rate design modules, with some effects also evident in revenue requirements and cost allocation procedures.

However, moving to an integrated solid waste system with variable rates will involve a considerable amount of staff work. The solid waste system, its customer groups,

revenue sources, services, and costs must be examined in detail and the relationships understood by staff.

Because some of the terminology and concepts are confusing to discuss in the abstract, this section includes illustrations and examples, largely drawn from a case study of Seattle, Washington. These illustrations certainly do not provide answers that are applicable everywhere: rather, they are used to clarify points, techniques, or objectives. Every solid waste jurisdiction is configured differently, with different customer types and services offered. The specifics shown in the examples would need to be significantly modified to fit the jurisdiction's situation.

1.0 MODULE 1: DEMAND

This part of the rate study estimates the demand for each type of service offered for each customer class. These estimates of services demanded are used in the revenue requirements, cost allocation, and rates calculation sections. Depending on the sophistication of the analysis, the demand module may include a variety of socio-economic variables, estimated equations and relationships, and starting values for the variables.

The demand section generates estimates of the number of tons disposed (by program or customer type), customer counts by type, and service levels demanded (cans or bags/tags). Customer counts and tonnage by type of service and service levels are used in estimating the cost of providing the various services (module 2). The number of customers, tonnages, and service units are used in determining the allocation of costs and the final rates (modules 3 and 4).

The jurisdiction must carefully list every type of service that it offers to customers that leads to a cost or that it may charge a rate for. In addition, it must determine every customer group that uses these services that may demand the service and/or be charged for its use.

The types of service that a jurisdiction may offer generally include one or more of the following:

- collection and disposal from cans or bags/tags
- collection and disposal from dumpsters
- transfer station services (transfer, hauling and disposal),
- a variety of recycling and/or yard waste programs (collection or drop off),
- landfilling or other disposal services (incineration, etc.).
- other optional services (including differentiations like distance from curb, curb vs. carry-out, bulky-item service, etc.)

Customer segments for any or all of these services may include:

- single-family
- multi-family
- commercial establishments
- industrial establishments
- self-haul or drop off customers
- large commercial haulers
- others.

The basic steps involved in a volume-based rate analysis include:

1.1) Estimate the number of customers using each type of service you plan to charge for (residential dumpster service, transfer station customers, single family vs. multi-family pickup, etc.)

1.2) Forecast the number of tons disposed by aggregate sectors (residential, commercial, etc.) based on rate and economic effects and other factors

1.3) Forecast tonnage for new recycling programs by customer class, including recycling program volumes or tons collected and program volume diverted from any existing private recycling

1.4) Disaggregate net tonnage (for solid waste and recycling) into component customer classes (e.g., residential may need to be disaggregated into dumpster vs. non-dumpster volumes)

1.5) Using net tonnage by customer class and rate effects, determine new service levels by customer class and estimate the number of participants for recycling and yard waste programs.

1.1 ESTIMATING CUSTOMER COUNTS

Customer count information is used in two major places in the rate analysis: for estimating the costs of providing service, and for dividing the revenue requirements among users to determine rates. However, in some cases, costs and rates will not be customer based, but will be solely calculated on a tonnage basis. In this case, the jurisdiction may not need to generate estimates of sheer numbers of customers.

Estimates of customer counts for residential pick-up by class usually consist of current data on customer counts and extrapolations based on forecasts of growth in number of households.[2] Useful forecasts of growth are usually available from local

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[2] If commercial customers are also part of the customer base for the solid waste jurisdiction, then counts of businesses, etc. may also be needed. Similar sources for information may be useful, as well as Chambers of Commerce or state Departments of Revenue. Note that this section on the process for determining rates concentrates

economic entities (offices of planning, city/county budget departments, etc.) or from other local utilities. These entities usually provide separate growth information for single-family vs. multi-family households. Other possible sources of information may be data on demolitions and housing starts or, in a pinch, extrapolation based on customer counts over the last few years.

Customer counts for other services (such as transfer station or landfill usage, etc.) may be needed if: customers are charged set fees per use (per auto trip), or if a known relationship exists between the number of customers visiting the transfer station or landfill and the cost of operating that facility. In this case, the customer counts would be used in generating estimates of revenue requirements, and determining the level of rates.

1.2 ESTIMATING TONNAGE OR VOLUME DISPOSED BY TYPE OF SERVICE

The purpose of this part of the rates analysis is to determine the number of tons or volume that will be disposed by customers through each type of solid waste service that the jurisdiction provides. The estimate or forecast will be used in determining the cost of providing service to customers in the revenue requirements section, in estimating the amount that users of each type of service should pay in the cost allocation sections, as well as in determining the final level of rates.

Estimating the number of tons (or volume) disposed can be done at several levels of sophistication. The simplest method is to use a trend analysis. In the case of jurisdictions with minimal data available and with few changes in the basic system, this may be all that is possible.

However, changing to a variable rate system may impose more changes in behavior than would be reflected in a trend-type analysis. More sophisticated analyses would require more steps.

The approach economists take in dealing with this problem would be to generate a forecasting equation. This econometric analysis would involve gathering historical data on tonnage or volume by program and customer type, as well as historical (and forecast) values of socio-economic (causal) and possibly programmatic data. Using a combination of common sense and an examination of the economic literature in solid waste and other utilities would lead to a list of variables or factors that the modeler believes might tend to influence the demand for solid waste collection.

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on the residential portion of the customers.

A partial list of variables in a demand equation for solid waste collection might include:

Residential:

- o the price for collection/disposal services
- o income
- o family size
- o price of recyclables
- o rainfall or other weather/climate variables
- o population
- o other

Non-residential:

- o price for collection/disposal services
- o price of recyclables or other options for diverting waste
- o rainfall or other weather/climate variables
- o number of employees
- o type of business
- o other

As mentioned before, there are a multitude of other variables or different forms of variables that could presumably have an effect, including population, age distribution of the population, the strength of the local recycling alternatives, etc. Which variables will turn out to be significant in any specific jurisdiction will depend on a number of factors, including which data are available for the necessary time period, the functional form that is estimated, the quality of the data, and the time and staff available for the estimation work.

Generally, we would expect that the relationship between the price of disposal and the tonnage or volume disposed would be an inverse relationship.[3] That is, as rates

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[3] Most jurisdictions that have estimated demand equations for residential collection and disposal use some measure of average price for the service levels. Empirical

go up, waste reduction and recycling would be encouraged, and the amount of tonnage left over to be disposed of would be lower. An empirical relationship of this type may be difficult to estimate in a jurisdiction that has not experienced a true price or rate before, especially as prices have not traditionally varied with amount disposed. As variable can rates are introduced, we would expect that rates would have a much bigger effect on the amount disposed.

For jurisdictions in this predicament, there are several options. The jurisdiction may choose to 'adopt' a relationship from another jurisdiction. Alternatively, they may decide that for the first year or two, the effect of prices will not be as significant because customers are just getting used to prices, and it will take time to modify their behavior. The Appendix at the end of this section includes a summary of two models of demand for residential services that may be useful.

Many of the needed types of socio-economic and other data are currently collected and being used by your local electric, gas, or water utility for its forecasting work. It would likely be very fruitful to have a discussion with forecasting staff from these utilities in data collection efforts and planning the solid waste rates work. Many of the same types of models are very applicable to the solid waste arena.

1.3 FORECASTING RECYCLING TONNAGE AND PARTICIPATION

This section is closely tied with the previous estimation of solid waste tonnage or volume by sector. The estimation of garbage disposed will generally include a price- or rate-related variable (and may or may not include a variable explicitly reflecting recycling). This price variable reflects the amount that garbage tonnage or volume decrease as the price of disposing of the waste increases. The variable represents the net of two effects: a generation effect, reflecting the fact that people might purchase items with less bulky packaging or fewer items in general; and a diversion, or recycling effect, reflecting the amount of tonnage or volume that is diverted to recycling activities.

Because the relationship described above is estimated using historical data, the relationship cannot account for any new, convenient recycling programs that may be introduced by the jurisdiction or by private industry. Rather, it represents recycling and waste activities that were induced through historical rates and programs. New programs will generally represent a significant enough change in the system that it cannot be accounted for through a historical modelling approach. In the case of new programs, it will be necessary to develop separate estimates for the amount of

results using the preferred measure, the 'marginal' cost for additional service levels, have not been as strong. Work is continuing in this area.

ILLUSTRATION

Assume a hypothetical solid waste jurisdiction that, based on historical information, estimates an explanatory relationship for residential tonnage that takes the following form:

Annual residential tonnage disposed per household =
constant term
+ (a x change in average rate)
+ (b x growth in income)
+ (c x household size).

Assume the specific relationship is as follows:
a=-0.14; b=+0.60; c=+0.70

Residential tonnage disposed per household for 1989 = 0.82
+ (-0.14 x ($156/yr-$144/year)/$144/year))
+ (+0.6 x ($29,000/yr-$28,500/year)/$28,500/year))
+ (+0.7 x (2.01pph-2.0pph/2.0pph)).

This equation would lead to a forecast of tonnage disposed per household for 1989 of:

.82 tons - (.14*.083) + (.6*.0175) + (.7*.02) =
.833 tons per household.

If the jurisdiction predicts 438,000 residential households, then the total projected residential tonnage is 365,000 tons per year.

programs will generally represent a significant enough change in the system that it cannot be accounted for through a historical modelling approach. In the case of new programs, it will be necessary to develop separate estimates for the amount of tonnage or volume that is expected to be diverted to the new programs.

Estimates of tonnage or volume that will be gathered by each additional new program will need to be developed. This work is not conceptually difficult, although care will need to be taken to examine each program individually, and to develop estimates that pay attention to the waste composition to assure that the programs do not forecast more tonnage diverted for any particular waste stream component than is in the original waste stream.

The new estimate of tonnage to be disposed of by service will consist of the net of two numbers:

Final Tonnage Disposed	=	Estimated Tonnage Disposed	-	Estimated Tonnage Diverted by Additional Recycling Programs

Unfortunately, a multitude of factors will affect the amount of tonnage or volume that will be collected by the new programs, and there is no hard and fast rule or existing relationship that will give a number for the amount that will be diverted. The information in the Table on pages I.46-47 in Part I of this document, "Feasibility" may prove helpful on this point.

The estimate of program recycling tonnage will be based on:

- o Total amount of the material in the waste stream
- o Achievable tonnage
- o Ramp up pattern

In more detailed steps, the estimate of recycling program tonnage will need to be built up based on a variety of factors, most of which will vary based on the design of each individual program, such as:

- o the number of customers eligible for the program (this includes determining the targeted customer sector).
- o the total amount of tonnage or volume of that type of waste that is in the disposal waste stream for that sector (based on a waste stream composition). This must take into account the effects of other existing or planned programs affecting the same component of the waste stream.
- o the 'effectiveness' of the program (how much of the total amount being disposed will likely be diverted by the program). This consists of two parts: 1) participation, the percentage of eligible households that can be expected to participate, and 2), the volumes per household, or the 'efficiency' or amount (or percentage) of the waste that is actually diverted from each average

participating household. These will be affected by the convenience of the program, the likely cooperativeness of the customers, and the amount of funds and effort that will be put into public education, advertising, and program promotion.

- o Information on these factors will need to be estimated for both the long-term program, as well as the "ramping-up" period. The expected pattern of the ramp-up will need to be projected. This again may be based on advertisement as well as physical factors or limitations (e.g., only so many special containers can be delivered per month, etc.).

Illustration: A program is designed that will provide curbside collection of separated yard waste for single-family residential customers. Assume yard waste makes up 20% of the residential waste stream that has been forecast at 1000 tons per day (or 365,000 tons per year), and that single-family households make up 60% of the households in the city, and 85% of the City's residential buildings. It may be reasonable to assume that the amount of yard waste is more closely related to the number of buildings (i.e. "yards") than to the number of households. Therefore, an estimate might be that 85% of the yard waste is attributable to single family households.[4] Making these assumptions would imply that a total of about 170 tons per day, or 62,000 tons per year, of yard waste is eligible for this program (365,000 x .85 x .2).

Assume that a big promotion is planned, or that a very low or zero rate is proposed for the program (and that regular garbage rates charge significantly more for additional waste), or that the program is planned to be mandatory. Assumptions like this would tend to lead to an expectation that the program would achieve a very high participation and efficiency rate. In addition, if it is assumed that the customer does not have to sign-up, or if no special containers or bags are needed and waste can just be left out for collection, then the program may be expected to ramp-up fairly quickly (with few constraints).

Making assumptions on these factors -- for example that in the first year, 70% of customers sign-up and are about 80% efficient in getting the waste separated -- would lead to a result of about 35,000 tons collected from the program in the first year (62,000 eligible x .7 x .8 = 34,750). Assume a rapid ramp-up period. Assume by the second

[4] Additional information that your jurisdiction may have on relative lot sizes, or information on the type of yard waste or seasonal factors should all be taken into account.

year, we have 90% participation and 90% efficiency, and that we never get much higher participation or efficiency. We would then apply these percentages to the forecast for the second year of the program, and so on.

The tonnage diverted for each year based on this program would be calculated as:

> program tonnage diverted = total sector waste stream x percentage of targeted material in waste stream x percentage for eligible sector x percentage participating x assumed efficiency.

The new forecast for the tonnage disposed for the residential sector for the first year would be the disposal forecast minus the diverted tonnage forecast for each program.

Disposed tons = 365,000 tons-(365,000 x .2 x .85 x .70 x .85) - tonnage diverted by other programs.

Applying this methodology to each program requires making several assumptions for each program. Some may ramp-up quickly to high diversion levels, others may require assumptions of slower "phasing in" (either because of physical constraints, or the need for extensive education of the public, or because of lower program convenience). Some programs may focus on waste that is more difficult for customers to separate, and these programs may never reach very high efficiency levels.

Each program will need to be analyzed on this basis. Although the work seems overwhelming, the concept is not difficult.[5] In addition, the staff from the

[5] Note that this same type of analysis can be used in determining which types of diversion programs to propose. The tonnage that would be diverted, and the costs that would be incurred, can be compared with the costs of traditional disposal ("avoided costs") to determine which types of recycling/waste reduction programs will be cost-effective for the jurisdiction to undertake. In calculating the cost-effectiveness, a long-term perspective should be adopted. A recycling program will likely incur more up-front fixed costs than continuing traditional disposal methods. However, traditional disposal methods have large fixed costs in later years (some jurisdictions would incur these costs later than others). Comparisons should not be done for too short a time period so that it can more fairly reflect these very real costs. For more information on

conservation program department of your local electric or water utility may be very helpful[6]. There is a high degree of similarity of techniques and objectives for conservation of the commodities sold by these other utilities.

<u>Tonnage or Volume Overlap</u>:

One additional complicating factor needs explanation. The previous discussion provided an estimate of program tonnage. However, the amount of recycling tonnage that the jurisdiction sees will be a combination of the new program tonnage plus any tonnage that is diverted from existing recycling efforts. When the solid waste jurisdiction begins to introduce new recycling programs, it may see new tonnage or volumes that they never had to collect before. That is, customers who used to recycle waste through a private recycling program may begin giving that waste to the jurisdiction's recycling program.[7] This is especially likely to happen if the solid waste jurisdiction offers a program that is particularly convenient, or begins to offer credits off the bill for participation in a jurisdiction-sponsored recycling program. It will also be more likely if the jurisdiction's recycling program targets materials that are currently being collected through other means.

This means that a simple subtraction of the estimated program tonnage from the forecast solid waste tonnage will <u>underestimate</u> the total (garbage plus recycling) tonnage that the utility or jurisdiction will need to handle. In particular, the recycling program will likely achieve more tonnage than projected (or at least will get "credit" for more tonnage than it should) because it will divert tonnage from existing recycling programs.

Later portions of the rates analysis, particularly the revenue requirements section, uses projections of the total tonnage or volume collected by each program and customer sector in order to calculate total costs of the system. The module needs to know the tonnage or volume collected by a program to calculate total costs of the program. Information on both the new tonnage that is attributable to the program as well as the amount of tonnage that is diverted from previous or private efforts are also needed.

cost effectiveness of recycling programs, see Part III of this report, "Economic Feasibility of Waste Diversion Incentives".

[6] or the literature in professional and trade journals related to these industries.

[7] In a sense, it is as though the jurisdiction had underestimated the total potential volume of particular waste stream components that could potentially come to its program because the material had been diverted from the waste stream previously.

1.4 DISAGGREGATING TONNAGE FOR CUSTOMER CLASSES

This section may or may not be necessary, depending on the manner in which tonnages have been estimated. The purpose is to allow total system costs to be separated into costs attributable to the separate groups and rate classes or subclasses that the solid waste system may have. The information presented here is used in module 3, the "cost allocation" module.

For example, depending on how rates will be charged, it may be necessary to separate the amount of tonnage for the residential sector into variable can vs. dumpster tonnage, as well as into the amount of tonnage generated by single-family vs. multi-family customers.

There are a number of ways in which this separation may be conducted. For example, "sharing out" tonnage based on the relative numbers of households may be a fairly straightforward method of estimating tonnage by sector. This may be used "straight", or may be modified based on other information. For instance, there is some indication that multi-family households may dispose of less waste per household than single-family households (perhaps attributable to smaller household or yard size). Therefore, a modified per-household approach may be used.

The separation may be based on an average weight per cubic yard of dumpster service and adding up the cubic yards of dumpster service used by the jurisdiction's customers. This tonnage would be subtracted from the total sector forecast, with the remaining tonnage assigned to the variable can customers. Other alternatives may also be used.[8]

This type of exercise would generally be performed for each type of customer and each type of tonnage (for instance, garbage, recycling program 1, recycling program 2, etc.). Given a shortage of time or information, averages or a number of simplifying assumptions may, of course, be used.

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[8] Seattle's rate study used a number of equivalencies to separate tonnage by customer sector and to calculate the rates. These numbers were based on limited information, informal surveys, or some literature review. None of the numbers is irrefutable, and the numbers in other jurisdictions may vary based on waste composition and a number of other factors. Equivalencies used included 100-135 pounds per cubic yard of residential waste; 6.2 "cans" of waste per cubic yard container; 20-22 pounds per "can" of waste.

1.5 ESTIMATING VARIABLE CAN SUBSCRIPTION LEVELS OR PURCHASES OF BAGS/ TAGS

The purpose of this section is to use net garbage tonnage by customer class and rate effects to determine the number of cans that will be subscribed to, or bags that will be purchased by the residential customer class. In addition, estimates of the number of participants for programs for which revenues will be collected must be estimated. This section poses a particularly sticky problem for the solid waste jurisdiction that has not previously had variable rates.

Bag/Tag systems: This is not a particularly complex assignment under a bag system. Estimating the total number of bags to be sold would generally involve forecasting total residential tonnage and dividing it by the average expected weight per bag/tag.[9] For purposes of determining rates, it is generally not important how many bags or tags are put out by a particular customer each week. There is generally no variation in price based on the number of bags used, so although the level of revenues is tied to the number of bags sold, no variation in separate bag rates needs to be calculated. However, because of the more complex (or flexible) rate structure that is used under a variable can system, the calculations require that the distribution of the number of cans subscribed per household be known.

Variable Can Subscriptions: For jurisdictions implementing a variable can system, not only will starting subscription levels be needed, but assumptions will also need to be developed that lead to estimates of how the starting subscription levels will change over time given two important factors:

- changes in the rates, and
- changes in tonnage.[10]

The reason this is a critical section is that the revenues for the residential sector under a variable can rate structure are intimately related to the number of cans

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[9] This sounds fairly straightforward, but there are complications involved. It may not be known how full customers will fill the bags a priori, and the amount of material that they may put in the bags (and their incentives to compact the waste) may change over time. This could be a factor of getting used to the system, rate incentives, etc. So the average weight may not be known at the beginning of the program, and the average weight per bag may change over time as the program matures.

[10] This could be due to recycling programs. Other changes that would affect cans subscribed would include the introduction of new service levels or service options, etc.

charges through property taxes, only two basic items are required: residential revenue requirements and a forecast of the number of households. Forecasting the number of households in the service territory is considerably less complicated and risky than generating a reliable forecast of the profile of cans subscribed for residential households. This means that collecting total revenue requirements will generally be less certain when a variable can structure is introduced than under the fixed rate scenario.

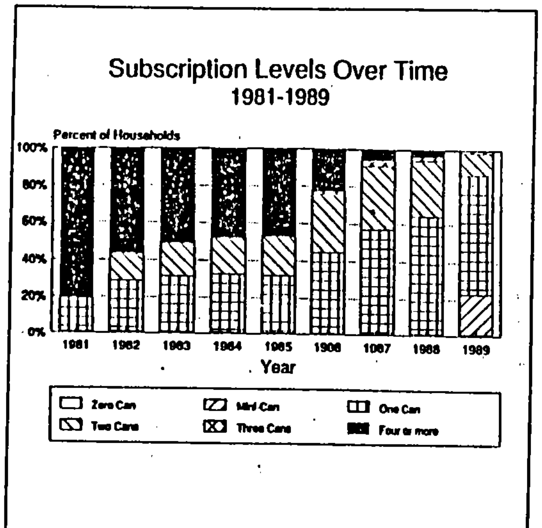

Figure 2

However, the task is not impossible. Also, with some extra work, the approximate range of the risk can be assessed. Figure 2 shows the pattern of subscription levels over time in Seattle. Clearly, Seattle's customers selected very high service levels in the early years of the variable can program. This is partly because the subscription levels available were weighted fairly heavily toward high levels, the default service levels were set high, and because there were large increments between the subscription levels available. In addition, the rate levels were relatively lower in the early years, and the incremental rates charged for additional service levels were fairly low.

Subscription levels declined very quickly with increases in the base rates, and increases in the relative amounts charged for additional cans.[11] Several factors allowed this change. One of the major factors was decreasing enforcement of

[11] A table of Seattle's residential rates during this period is included in the case study at the end of this volume.

increases in the relative amounts charged for additional cans.[11] Several factors allowed this change. One of the major factors was decreasing enforcement of service levels. Another was the increase in recycling through private recycling firms during this period. Third, the Utility began to offer more service levels, with smaller increments between the levels offered.

Seattle's example is provided to illustrate the fact that the starting service levels, as well as the way in which the subscriptions will change over time, will be influenced by how the variable can system is set up and the current solid waste characteristics of the jurisdiction. Influential factors include:

- the average amount of waste currently put out by customers,
- the amount of recycling currently being done,
- the service level choices offered to customers and the increments between service levels,
- the level of rates and the steepness of the rate structure (the amount charged for extra cans),
- the degree of enforcement of service levels, and
- the "default" service level for customers who do not specify a service level.

Starting Levels: The first step in estimating the starting subscription levels is to estimate an average number of total cans that will be subscribed. A method that may provide an estimate of this would be to estimate an average weight per garbage can. Then the net garbage tonnage can be turned into an estimated total number of cans. All households would have to subscribe to at least a first can of service, and the remaining step would be to decide on the distribution of these "extra" cans among can subscription levels.

Subscription Adjustments: After the initial or starting subscription levels are determined, certain amounts of judgment are also necessary and appropriate in determining the amount by which subscription levels may be further modified with respect to changes in rates and tonnage levels. With the lack of historical information in a jurisdiction, judgment may be as valid as any alternatives.

Change mechanisms may be as non-empirical as assuming that, for example, 50% of customers with more than one can will reduce subscriptions by one service level. The assumption may be that the amount that subscriptions will change is higher for higher subscription levels and lower for first and second cans because there is more

[11] A table of Seattle's residential rates during this period is included in the case study at the end of this volume.

> Several things can be done by the jurisdiction to determine starting variable can service levels.
>
> - o The jurisdiction could conduct surveys or focus groups of customers to ask the level of service they would subscribe to given a series of rate scenarios and service level options.
> - o The solid waste jurisdiction could conduct visual inspections of the amount of waste put out at households and use those (or modifications of those) as starting distributions.
> - o Alternatively, a distribution from a jurisdiction that is judged to be in similar circumstances could be used.

room for reduction. That is, you might assume that customers on higher cans will tend to reduce their subscriptions more than those on lower cans because such a change involves a smaller percentage reduction and because they may face bigger increases in rates. Therefore, your adjustment mechanism might show greater proportions of adjustments at higher can levels.

More complex adjustment mechanisms would have separate adjustments based on at least two subscription drivers: tonnage changes and rate changes. The model could first adjust the overall subscription levels for changes in the amount of net tonnage due to either recycling programs or other effects. The total cans are assigned as "first cans" and "extra cans" based on dividing the net tons by an average weight per can and knowing the number of customer households. Another approach would be to reduce a larger proportion of high subscription levels to take account of the fact that reductions in higher subscription levels should be easier.

A second adjustment could then be made based on previous subscription levels and rate effects between various can levels. This would require elasticities for each can level -- that is, a numerical estimate of the reaction of customers at each subscription level to a rate change. Empirical work based on other situations may or may not lead to more accurate estimates than using judgment-based assumptions. However, preliminary work from Seattle is included in the Appendix to this section.

Judgment is an important factor in these analyses. With significant changes in the solid waste system, empirical work may not be very useful. Judgment may be all that is available until the new system is in place for a time and site-specific empirical

information can be collected.

Risk associated with subscription level forecasts: One very real option to increase the revenue reliability associated with a new variable can system is to set up a rate structure that does not charge vastly different rates for different can levels. In simple terms, this means coming close to charging an average amount per household again, but gives both the jurisdiction and the customers some time to adjust to the new system. For instance, if the fixed rate per household previously was $7 per month (assuming the same total revenue requirements for this sector), the new variable can system may start out by charging $6 per month for the first level of service, and only one dollar more per additional can. This would tend to increase revenue stability, and would increase the certainty that revenue requirements would be collected. However, it significantly decreases the recycling incentives associated with the variable can rates. Another option is to secure the costs by giving the jurisdiction the ability to use general fund revenues for shortfalls. One other approach is to test the revenue effects of a number of scenarios for subscription distributions when calculating the rates. Using both pessimistic and optimistic assumptions may help the jurisdiction 'bracket' the financial risk.

Given the possible financial uncertainty associated with the introduction of variable can rates, this kind of a phase-in may be a way to make the change in rate structure more palatable to policy-makers and to customers. It meets the general equity criteria that customers who dispose of more pay more, and that customers who reduce waste can pay lower bills. As time passes and the concept of varying rates becomes more acceptable, customers become better educated about alternatives, the jurisdiction gets better knowledge of customer behavior, and more programs are introduced, the rates can be modified to include stronger recycling incentives.

Interrelationships:

None of the sections of the analysis are "stand-alone". Rather, each includes a set of relationships that depend on answers that are generated in other parts of the analysis. The demand module generates estimates of tonnages and service types and other results that are used in several other modules of the analysis. In addition, the rate design part of the analysis will generally feed back into the tonnage forecasts generated in the demand equations described above. After all sections of the rates analysis are completed once through, the levels of rates estimated in the last part will be used in the demand equations to generate new, revised estimates of demand for the various services. These new estimates will then be used in the next run through the various parts of the rates analysis.

2.0 MODULE 2: REVENUE REQUIREMENTS ANALYSIS

This step analyzes the costs that would be incurred meeting the demand for the mix of services projected or forecast in the demand analysis. It attempts to estimate the total amount of revenues that need to be collected from all sources, including rate and non-rate revenues.

> The revenue requirements analysis is based on the sum of all expenditures that are needed to meet the demand. The analysis includes three steps:
>
> 1) Estimating all non-varying costs associated with serving the forecast demand, including any planned costs for system improvements, start-up costs for programs, overhead, etc.
> 2) Estimate cost relationships associated with serving the service needs that will vary based on the amount of service provided, or the customer counts, or revenues.
> 3) Determining whether revenue requirements need to be increased to meet any financial policies or guidelines.

The revenue requirements analysis needs to include every cost associated with running the agency and providing service because the rates that are calculated must produce enough revenue to cover those costs.[12]

For each current-type cost center identified by the solid waste jurisdiction, estimates of all types of costs will need to be determined. This includes generating estimates of the level of costs that are relatively fixed as well as formulaic relationships for those that will tend to vary with the amount of forecasted service determined in the

[12] To the extent that an agency might have some costs covered out of the general fund or taxes, a total revenue requirements analysis would still probably be needed. However, if it is known that only some costs would need to be covered from rates, a partial revenue requirements analysis could be performed.

demand section.[13] The estimated proportions of costs that are fixed vs. variable by cost center will also be used later in the cost allocation work.

Some of the costs will be fairly fixed, others more variable. For instance, the cost for internal labor and overhead may be fairly fixed. Some costs will vary only by inflation or not at all. Others will vary with tonnage, ton-miles, customer counts, programs, revenues, or other variables. Costs and relationships will vary based on the types of services provided by the jurisdiction. A careful analysis of the specific solid waste system will be needed to assure that any and all important cost-related relationships are included in determining the total of revenue requirements.

Once it is determined which types of costs vary and on what grounds they vary, the jurisdiction needs to determine how much of some of the factors is variable: e.g., it may be that only some portion of some costs may vary with tonnage or inflation. Special relationships may also need to be set up because costs that may increase with increased tonnage may not move downward with decreases in tonnage ("sticky downward"). For example, over the short term, the number of municipal jobs is generally fairly sticky downward (and upward) regardless of the tonnage that may be collected or the services provided. However, some labor costs may be variable with respect to demand, particularly items like overtime and temporary labor.

Other cost components that may vary fairly directly with the demand estimates provided from the demand analysis may include, for instance, disposal costs at a contracted landfill, or components of trucking operations (e.g. fuel costs). Another example is contracted services. Another example would be any contracted programs that with payments based on the number of tons collected. The level of taxes will tend to vary in a formulaic relationship with the level of revenues or income that the solid waste jurisdiction anticipates.

It may also be necessary to determine which items are variable in short term vs. long term, and take that into account based on the period over which the revenue requirements are being estimated. Economists usually assume that all costs are variable in the long run. In the short run (less than three years), capital expenditures are usually considered 100% fixed, and 100% variable in the longer run.

One method of proceeding is to examine the historical pattern of budget items one by one over time. This may help deduce which portion of costs is variable, what it

[13] For instance, one assumption may be that 90% of a particular type of labor is fixed, and 10% is variable based on tonnage. Or it may be assumed that all overtime is variable, and "kicks in" if tonnage exceeds a certain amount.

varies with, and which costs have risen with inflation, slower than inflation, or have outpaced inflation.

In some cases, the costs for the next years will be very closely related to previous years, and be simple functions of historical levels.[14] However, the introduction of variable rates may lead to significant changes in levels of expenditures required within specific cost centers (including possible increases in customer service and billing costs, and other items). In other cases, the system changes will create totally new types of costs that will be less simple to estimate. New cost centers may need to be added to cope with the new variable system or the new recycling programs.

The change to a new system may also precipitate new capital expenditures, especially likely in the areas of billing and recycling programs. Or the need for new investment may be created by the change in service mix or increased/decreased levels of tonnage collected. For instance, the addition of recycling programs may require the construction of a recycling processing center, or a special recycling collection truck. Estimates of these costs and the relationships with service, inflation, and other factors will need to be included in the analysis.

Estimates of the amount of capital expenditure to be apportioned to each year of the investment is usually some version of the total cost of the investment[15] apportioned across the number of years of useful lifetime of the investment.[16] In the case of the processing center, the lifetime may be 20 years, or for the truck, the cost of the truck would be divided by the useful lifetime of perhaps 7 years to calculate the annual cost.

The final step is to determine whether the financial guidelines that may govern the solid waste jurisdiction will be met by the combination of revenues and expenditures that are projected. However, the final projected revenues are a function of the rate design given in the last part of the schematic in Figure 1 and the services demanded based on the first part of the analysis. Therefore, the test of whether the policies are met will need to be established as formulas in the analysis.

Examples of the types of policies that might govern the financial operations include debt/equity ratios, minimum number of days of operating cash, and minimum net income requirements.

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[14] For example, costs that will increase with inflation levels.

[15] Possibly the cost of the investment less any salvage value, if appropriate.

[16] Some alternatives would be to base the yearly costs on a straight-line method, on the tonnage expected to be served each year of the lifetime, etc.

It will be important to perform a fairly thorough analysis at this stage if the jurisdiction wants to be able to retain a great deal of flexibility in the next stages of the analysis -- cost allocation and rate design. Any part of a cost item that you might want to allocate separately to a group of customers to make sure they pay for it will need to be included separately. For instance, if only customer group A visits the transfer station at night, then the relevant transfer station costs will need to be apportioned by day and night costs so the night costs can later be allocated to the proper customer group.

Illustration:

SAMPLE COST ITEMS FOR REVENUE REQUIREMENTS

Personnel-related:

Tend not to vary:	budgeted staff including direct and indirect labor, overhead, fringe, travel, education, dues and memberships, subscriptions
Tend to vary:	some labor costs, including staff, temporary, and overtime in certain operational areas, including: customer service, inspection, collection staff, recycling program staff, transfer station staff, hauling/drivers, landfill/incinerator

Supplies, Equipment & Services:

Tend not to vary:	budgeted office supplies, equipment and maintenance, office space and services, basic telephone, postage, duplicating
Tend to vary:	equipment at transfer station or hauling equipment (leasing/rental), fuel, maintenance, phones or other equipment for customer service, inspection, collection staff, transfer station staff, hauling/drivers, landfill/incinerator; operating supplies for landfill/incinerator, cans/bins for garbage or recycling program collection

Expert, Consulting, or Contracted Services:

Tend not to vary:	budgeted planned studies and assistance

Tend to vary:	public information/advertising, data processing services, recycling market development, recycling or program services or support, any contracted collection, hauling, or landfill or incinerator contracted services (e.g. tip fee)

Financial:

Tend not to vary:	capitalized equipment, land, principal and interest payments, depreciation
Tend to vary:	taxes, subsidies to low income customers, net income or other financial targets, some depreciation

This is just one method of breaking down the costs, and is based on a budget approach. Another method is to separate out the costs by functional area:

A list of examples of cost centers associated with <u>current</u> expenditures might include:

- o Residential collection
- o Transfer station operations
- o Landfill, incinerator or other disposal operations
- o Transportation/Hauling
- o Billing
- o Customer service
- o Recycling program operations
- o General and Administrative
- o Taxes
- o Interest
- o Other

Types of costs that will be included in current expenditures include 1) internal labor and overhead, 2) outside labor, and 3) other current expenditures.

Examples of cost centers associated with non-current expenditures include <u>capital expenditures</u> for the following types of items:

- o Garbage collection (trucks, etc. if municipal collection)
- o Transfer station modifications/improvements
- o Recycling program investments
- o Billing (new computers, etc.)
- o General and administrative (computers, equipment, etc.)
- o Landfill closure
- o other

Interrelationships:

The relationships included in the revenue requirements analysis depend on information generated in several other modules, including tonnage figures from the demand portion, and for the test of financial guidelines, the revenues generated from a combination of the demand and the rate design section.

3.0 MODULE 3: COST ALLOCATION

This module determines the way in which the total revenue requirements of the system will be borne by the solid waste jurisdiction's customers. It generally attributes costs and non-rate revenues to each customer class served based on the type and amount of service delivered, and assigns costs both between rate classes, and within rate classes.

In order to begin the cost allocation work, the jurisdiction must define the general customer rate classes. Then, the costs from each of the cost categories in the revenue requirements analysis (plus any non-rate revenue categories such as interest revenue, etc.) must be apportioned to the rate classes in a way that covers the entire costs. Some of the cost categories should be broken up into smaller entities, depending on whether particular subcategories of costs are generally attributed to one particular class of customers.

Generally, the costs that are used in a rate analysis are the same as budgeted costs, and the same basic analysis that goes into establishing the budget is that used in a rate analysis. First, the operations will generally be broken into a number of cost centers[17]. Depending on the type of services provided by the solid waste jurisdiction the general cost centers will differ. However, all costs of providing solid waste and associated services must be accounted for in this analysis.

Some of the cost centers will be associated with current expenditures (those associated with items with a useful lifetime of one year or less), and some will be associated with non-current expenditures (those with useful lifetimes of longer than one year).

Note that cost allocation includes a great deal of judgment. The way in which costs vary precisely based on which customers is often far from clear. A variety of allocation methods are available, but there are also discretionary and policy factors that may come into play. Examples are given below, but the ultimate allocations for a jurisdiction must reflect information about its specific service and customer patterns, and its policy and rate design objectives.

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[17] "Cost Centers" are categories into which costs are summarized. For instance, costs centers might be "labor", or "transfer stations".

The cost allocation process generally proceeds in two steps:

3.1) assignment of costs between rate classes, and
3.2) assignment of costs within rate classes.

3.1 ALLOCATIONS BETWEEN RATE CATEGORIES

For each customer/service group or rate class (and subcategories) the cost categories[18] are assigned by one of several possible allocation methods. Costs might be allocated on the basis of the number of customers, number of households, tonnage, proportionally, or some other method.[19] The result is a three-way "between categories" allocation matrix. An example of a "between rate classes" allocation matrix from Seattle is presented in Table 1. However, keep in mind that this allocation will not be appropriate to other jurisdiction's situations.

The solid waste cost categories that were derived in the revenue requirements section are generally aggregated in slightly different ways for the cost allocation. In this section, the costs may be re-aggregated into categories that reflect "packages" of assignable costs. The breakdown needs to be fine enough to allow the assignment of appropriate costs to specific customer groups. For example, this might be grouping costs into categories like transfer stations. However, to continue the previous example, if only one type of customer visits the transfer station at night and the jurisdiction believes that customer group should bear the cost burden of the night hours, then the costs at the transfer station will need to be broken down into day vs. evening costs.

Assignment methods for all rate classes and all cost (and non-rate revenue) categories must be completed in the cost allocation section. If, in the rate design

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[18] and non-rate revenue categories

[19] Economists would tend to allocate costs via one of two basic methods: 1) an average cost based method, or 2) a marginal cost based method. The simpler method is based on average costs, with the costs generally calculated as one of two types: those that should be apportioned on the basis of 1) tonnage for the class, or on the basis of 2) the number of accounts represented by the class. The marginal cost method would base the assignment of costs to mimic the cost of the last unit of service provided. This method would generally lead to rates that are more progressive, but requires considerably more data and analytical work on the part of the jurisdiction and is a complication that will not be addressed in this report.

module, it is decided that some rate classes will pay subsidized rates and will not be required to cover their entire cost-of-service, it will be necessary to allow for reassignments of the un-allocated costs to the other rate classes in the cost allocation module via similarly-established assignment criteria.[20]

Illustration: As an example, Seattle defines its classes of customers as variable can collection, dumpster collection, transfer station auto traffic, and other transfer station customers (generally commercial).

Seattle assigns its variable can collection customers costs in the following way. Collection contract costs, transport and hauling, weekday portions of the transfer station operations, landfill closure expenditures, general and administrative, disposal costs, recycling costs, interest revenues, and depreciation are all assigned on the basis of the proportion of total tonnage assigned to the variable can class. Billing costs are assigned on the basis of the proportion of billed customers that are represented by variable can customers. None of the costs associated with the weekend operation of the transfer stations were assigned to the variable can customers because all transfer of variable can tonnage occurs on the weekdays[21]. Similar assignment methodologies are determined for the other rate classes. In Seattle's case, taxes[22] are assigned proportionally on the basis of revenues from that sector, since they are revenue-based taxes.

3.2 ALLOCATION WITHIN RATE CATEGORIES

The first stage of the allocation established criteria for assigning total costs to each of several general customer groups. For each of the customer categories and each of the types of rates charged, the costs that were assigned to that customer class are divided among the set of components of the rates.

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[20] An example of a rate class for which Seattle charges rates that are less than full cost-of-service include special subsidized rates for low income customers.

[21] The bulk of weekend transfer station costs are instead assigned to the automobile self-haul customers.

[22] and the extra revenues required to meet the Utility's financial constraint of a 3% minimum net income

Table 1. Current Allocation of Costs/Non-Rate Revenues Between Rate Categories

Cost Centers / Non-Rate Revenue	Collection		Self-haul		Private Haulers
	Variable Can	Dumpster	Autos	Cash/Credit	
Collection (net of rental)	tonnage	tonnage	0	0	
Rental	0	all	0	0	
Transport/Haul	tonnage	tonnage	tonnage	tonnage	
H Trans Station:					
Weekends	0	0	all	0	
Weekdays	tonnage	tonnage	tonnage	tonnage	
S Trans Station:					
Weekends	0	0	all	0	
Weekdays	tonnage	tonnage	tonnage	tonnage	
Landfill Closure (inc. O&M, amort, depr., interest exp.)	tonnage	tonnage	tonnage	tonnage	% of costs (surtax)
G&A	tonnage	tonnage	tonnage	tonnage	
Billing:					
Variable Can	all	0	0	0	
Dumpster	0	all	0	0	
Commercial	0	0	0	all	
Other	% accounts	% accounts	0	0	
Cedar Hills	tonnage	tonnage	tonnage	tonnage	
Recycling/Waste Reduction	tonnage	tonnage	tonnage	tonnage	
Depreciation	tonnage	tonnage	tonnage	tonnage	
UIEM Credits					
Variable Can	all	0	0	0	
Dumpster	0	all	0	0	
Taxes	proportionally	proportionally	proportionally	proportionally	
Net Income	proportionally	proportionally	proportionally	proportionally	
Interest Revenue	tonnage	tonnage	tonnage	tonnage	
Sticker Revenue	all	0	0	0	

Source: 1989-90 Solid Waste Rate Study, Seattle Solid Waste Utility

The next step is to decide how each of the cost categories will be allocated within a rate class. In this analysis, if the rate design indicates that the customer's rates are to be made up of several components, then the allocation matrix would need to take this into account and assign costs to each of the rate components. For example, if the total dumpster rate for a particular customer class is to be broken into a component based on the number of customers, another based on number of pickups, another based on disposal volume, then the cost elements must be allocated to each of these rate components.

For some customer classes, rates are a simple "tonnage"-based rate. That is, the jurisdiction may choose to charge landfill or transfer station customers may be charged strictly by the number of tons brought in, and not an additional customer charge or the like. In that case, the costs that were assigned to the transfer station rate class (from each source) are not further divided into parts within the customer class before the rates are calculated. The costs are merely each allocated based on the calculated tonnage. For customers with this type of rate design the final level of the rate is determined by dividing the total costs (less non-rate revenues) that are assigned to this customer class by the number of forecasted tons of service for the rate class.

Other customers may have rates that are slightly more complex, and may include both a customer charge and a tonnage portion. If a bag system is used, and the charge is going to be a two-part structure (a customer charge and a per-bag variable fee), then the total costs (by source) that were assigned to bag/tag customers would need to be disaggregated into the customer charge and bag charge based on an apportionment methodology. One appropriate mechanism may be to assign all billing costs to the customer charge, and to allow all other cost categories to be assigned to the bag price on the basis of tonnage.

For variable can customers, the rate structure may have embedded in it several components, and the manner of how they are apportioned affects the "steepness" of the rate design. Generally, assigning a large portion of costs on the basis of tonnage -- and fewer on the basis of the number of customers -- will lead to rates that include stronger recycling incentives. That is because fewer of the costs end up in what is in essence a "customer charge", and more will be assigned to the part that is variable based on the number of cans subscribed.

Several examples of the allocation of revenue requirements within customer rate classes are provided in Tables 2 and 3. The examples are from Seattle, and are presented to illustrate the methodology discussed above.

3.3 IMPORTANCE OF PLANNING AHEAD

In order to maintain flexibility in being able to set rates that meet the jurisdiction's objectives in terms of incentives and inter-relationships, it is important that the analyst and decision-makers plan ahead and evaluate the plans for rate structures. Preparing mock-ups of these cost allocation and rate design matrices early in your modeling will help assure that you have collected your costs and carried them through the model in a sufficient level of detail (or disaggregation) to assure you retain the most flexibility in apportioning costs in the way you want.

Table 2. Allocation of Costs/Non-Rate Revenues Within Variable Can Category

Variable Can Costs	Customer Charge	First Can	Additional Can
Collection	0	87.5%	12.5%
Transport/Haul	0	tonnage	tonnage
Transfer Stations (weekdays)	0	tonnage	tonnage
Landfill Closure (inc. O&M, amort, depr., interest exp.)	0	all	0
G&A	0	tonnage	tonnage
Billing	all	0	0
Cedar Hills	0	tonnage	tonnage
Recycling/Waste Reduction	0	tonnage	tonnage
Interest	0	tonnage	tonnage
Depreciation	0	tonnage	tonnage
LIEM Credits			
First Can	0	all	0
Additional Cans	0	0	all
Taxes	proportionally	proportionally	proportionally
Net Income	proportionally	proportionally	proportionally
Interest Revenue	0	tonnage	tonnage
Sticker Revenue	0	tonnage	tonnage

Source: 1989-90 Solid Waste Rate Study, Seattle Solid Waste Utility

Table 3. Allocation of Costs/Non-Rate Revenues Within Dumpster Category

Dumpster Costs	Customer Charge	Rental Charge	Pickup Charge	Container Charge	Disposal Charge
Collection (net of rental)	0	0	34%	56%	0
Dumpster Rental Charge	0	all	0	0	0
Transport/Haul	0	0	0	0	all
Transfer Stations (weekdays)	0	0	0	0	all
Landfill Closure (inc. O&M, amort, depr., interest exp.)	0	0	0	0	all
G&A	0	0	0	0	all
Billing	all	0	0	0	0
Cedar Hills	0	0	0	0	all
Resource Recovery	0	0	0	0	all
Depreciation	0	0	0	0	all
LIEM Credits	0	0	0	0	all
Taxes	proportionally	0	proportionally	proportionally	proportionally
Net Income	proportionally	0	proportionally	proportionally	proportionally
Interest Revenue	0	0	0	0	all

Source: 1989-90 Solid Waste Rate Study, Seattle Solid Waste Utility

This will require work and planning. Achieving flexibility would argue that the costs and rate components be highly disaggregated. This allows them to be aggregated in any number of ways to create and design rates. However, the tradeoff is that the more detail and further disaggregation will require more work up-front in collecting detailed information on the sources of costs and understanding the system in more detail. However, it gives more flexibility in the way that costs can be assigned and rates can be designed. It will also save a great deal of back-tracking if decision-makers ask for rate scenarios that might not have been included in the original rate proposal.

<u>Interrelationships</u>:

Clearly, there is considerable overlap between the latter stages of the cost allocation analysis and the rate design and rates calculations analysis. The amount of costs allocated to customers classes will vary as the amount of tonnage estimated in the demand section changes.

4.0 MODULE 4: RATE DESIGN AND CALCULATING RATES:

> This part of the analysis performs two main functions:
>
> 1) determines the form and components of rates for the various customer classes and services, and
> 2) determines relationships between rates that will be equitable and provide for consistent incentives.

In this section, the solid waste jurisdiction determines which customer sectors will be charged for service via a strictly per-ton rate, which will be charged on the basis of number of visits, which will receive subsidies or penalties based on incentives, and which will have rates with other designs. It will also determine the structure of subscription-based rates. This is also where an analysis of policy-based deviations from cost-of-service rates may be invoked.

Illustration: For example, in Seattle, the list of the types of rates that needed to be calculated for services included:

- Variable can rates for each service level for curbside collection for the following customer groups: 1) single-family; 2) multi-family; 3) single family low income; 4) multi-family low income.
- Variable can rates for each service level for backyard collection for the following customer groups: 1) single-family; 2) multi-family; 3) single family low income; 4) multi-family low income.
- Dumpster service for a variety of service levels, and collection frequencies.
- Subscription rates for the yard waste program
- Transfer station per-ton rates and minimum charge rates for the following customer classes 1) self haul; 2) yard waste; 3) charitable organizations; 4) household hazardous waste.
- Per-visit rates for automobile customers at the transfer station
- Per-visit rates for automobile customers at the transfer station for household hazardous waste customers.
- Charges for optional or special services such as special pick-ups, bulky items,

As mentioned in the previous paragraphs, determining the level of rates for per-ton (or per-trip) customers is straightforward. That sector's share of total allocated costs and non-rate revenues is divided by the number of tons (or trips) forecast for the sector, and the result is the per-ton (trip) rate. For example, if the total revenue requirements assigned to the self-haul commercial customers is $750,000, and the number of tons forecast for the self-haul commercial sector is 15,000, the per-ton rate would be $50 per ton.

Rates must be assigned to all customer types and services. They are calculated using results and relationships from the demand, revenue requirements, and cost allocation modules. Some will be based on actual cost of service. Others will be apportioned based on formulas. For instance, it may be that multi-family variable can rates should be lower than single-family rates because the cost of service may be somewhat lower. Another example would be using a formula to determine the amount of the surcharge that should be charged for premium levels of service, or the discount that should be offered to low income customers. Rather than complicating the revenue requirements or cost allocation sections, a formulaic relationship between the rates calculations can provide this differential.[24] Still other rates will simply be assigned (particularly items that are too small to model, or that represent pass-through charges).[25]

Policy considerations will determine whether subsidies are appropriate for some customer sectors. This may be based on a number of criteria. It may be that a lower rate is desired for a segment of low income customers. It may be that in order to retain a customer sector that has competitive alternatives, a rate that is lower than full cost-of-service is needed. If these types of subsidies are employed, the excess costs must be reallocated to other customer segments as part of the cost allocation analysis. Other examples of subsidies would be below-cost-of-

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[23] Note that Seattle does not operate a landfill, so no rates are established for that service.

[24] For instance, based on policy considerations, Seattle charged a 40% premium for carry-out variable can service over the curbside rates. Qualified low income elderly or handicapped customers received approximately 50% off the standard variable can rates. In a change from previous rate calculations, the differential between single-family vs. multi-family variable can rates was eliminated. For policy reasons, higher subscription levels were priced above cost of service, and lower levels subsidized.

[25] Examples of these types of items might include small pilot programs or pass-through items like replacement toters.

service or zero rates for recycling services.

Policy considerations may again be employed if the solid waste jurisdiction wishes to deviate from calculated cost of service to generate variable can rates with higher recycling incentives. In this case, the cost allocation methodology might be modified to either reallocate excess revenues that are generated from overcharging higher can levels, or to reapportion the subsidy given to lower can levels.

Illustration: Seattle's variable can rates were designed to consist of three components: a "customer charge", a "stopping charge", and a "tonnage charge". The customer charge was defined to cover costs that are basic to the existence of a City-wide solid waste service, are not tonnage related, and are related to City policy. For instance, the customer charge includes the cost of landfill closure, the cost of the low income subsidy (city policy), billing costs, the cost of the recycling programs that are available to all variable can customers. All variable can customers pay this customer charge.

The "stopping charge" includes the non-tonnage related cost of Seattle's residential collection contract.

Finally, the "tonnage charge" generally includes the tonnage portion of the residential collection contract, the disposal cost, transfer station and hauling costs. Seattle wished to increase the recycling incentive by increasing the amount of rate on higher can levels. The extra revenues were then used to reduce the level of the rates for lower can levels.

Evaluating Equity and Consistent Incentives between Rate Levels:

Rate planners must work to insure that all customer groups pay a fair share of system costs. It may be that some costs, such as landfill closure cost, should be borne equally by all the households in a city, while the cost of stopping in a garbage truck should be paid on a per-structure basis. Other equity issues include:

- o Equity between single family and multi-family rates
- o Equity between rates charged to different sized buildings
- o Equity between dumpster and can/bag customers

The analyst must examine the how sensible are the calculated rates, and how the rates perform on the basis of the incentives provided and equity considerations before proposing them to management.

Interrelationships:

The rate designs from this section are used extensively in the cost allocation section. In addition, the rates calculated in this section of the rates determination are cycled back into the demand portion.

Because the rates determined in this section are almost certainly not equal to the rates that were used as starting values in the demand section, these new rates will lead to different estimates of the demand for quantity and mix of services. These new levels then are used in recalculating the demand, revenue requirements, cost allocation. Newly determined rates are used to adjust demand estimates until only small changes in the values of the projections are found between cycles. At this point, "equilibrium" is reached, and the cycling stops.

5.0 SUMMARY

The rates analysis described should be somewhat similar to the calculations that are currently used to determine overall costs of current solid waste service. However, the discussion attempted to highlight modifications that would be likely to be needed with the introduction of variable can service. These are concentrated in the demand, cost allocation, and rate design sections of the analysis.

One thing to remember is that judgment is an important part of all of these analyses. Equations are not a total substitute for "knowing" the particular solid waste jurisdiction. In addition, equations are not good predictors when significant changes over historical operations are proposed. In determining what will happen to the solid waste system, consistent and "reasonable" assumptions should be made. To the extent possible, lessons learned at similar jurisdictions or at other utilities in your area should be used. However, be aware that your predictions will not be "right" the first time. But you should also realize that the predictions and assumptions can be changed as the system evolves over time and as more information is gathered. The costs during start-up may be recovered in later years, and in general, the overall system will be fairer and more sound in the longer run.

EXAMPLE OF RESIDENTIAL DEMAND EQUATIONS

Seattle estimated the following forecasting equation for longer-term tonnage demand for residential pick-up and disposal service:[26]

Change in annual residential pounds disposed per household=[27]

Coefficient	Variable
	(constant term)
-0.14	(the percentage change in the average price of disposal),
+0.59	(the percentage change in household income),
+0.72	(the percentage change in household size),
-0.03	(the percentage change in the market price of recycled newspaper.

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[26] Seattle's equation was estimated as a function of logs of first differences of pounds per household. Equations for other sectors were also estimated. The equation for automobile self-haul transfer station customers estimated the number of automobile trips as a function of per capita income and the auto rate charged at the transfer station. Seattle's equation forecasting self-haul commercial tonnage at the transfer station was a function of the tipping fee at competing regional transfer stations, the tipping fee at Seattle's transfer station, and the level of employment in the construction sector.

[27] The estimated elasticities from Seattle's equations are generally the expected size and sign. Generally, we would expect that increases in the price of disposal would tend to decrease the tonnage disposed. That is, as rates go up, waste reduction and recycling would be encouraged and tonnage disposed would be lower. This would mean a negative sign on those estimated coefficients. Increasing levels of household income and household size would be expected to increase the amount of waste disposed per household, so these coefficients would have a positive sign. In addition, the elasticity for household size is less than one, which implies that as household size doubles, waste disposed increases, but by less than a doubling. The coefficient on the recycling price may not be expected in other jurisdictions. Seattle has had a fairly active private recycling industry for some time.

The following equation was estimated by Robin R. Jenkins,[28] using pooled monthly data from nine jurisdictions resulted in the following coefficients.

Residential waste disposed per capita per day =

Coefficient	Variable
-0.10	(user fee)
-0.00	(average household income, unlike the other variables, this coefficient was insignificant)
0.02	(mean temperature)
0.04	(average precipitation)
-8.36	(average household size)
0.33	(age distribution of the population)
0.004	(population density)
-0.01	(price received for used newspapers)

The Jenkins equation resulted in an elasticity with respect to user fee that was very close to Seattle's (-0.1257 compared to Seattle's estimate of -0.14).

PRELIMINARY EMPIRICAL WORK ON ELASTICITIES FROM SEATTLE'S VARIABLE CAN SYSTEM

Preliminary work in Seattle indicated that customers on lower subscription levels showed a lower propensity to change with changes in rates. This is partly because there were few lower subscription levels available to them, and partly because the percentage of waste that would need to be recycled would be much higher in moving from 2 cans to 1 can than from 4 cans to 3 cans.

In its 1989/1990 rate study, Seattle developed a set of elasticities to approximate the reaction of customer subscriptions to changes in rates for each variable can subscription level. The study used the following elasticities.

One can to zero can: -0.01
Two cans to one can: -1.00
Three cans to two cans: -1.53

[28] Jenkins, Robin R., Municipal Demand for Solid Waste Disposal Services: The Impact of User Fees, Ph.D. Dissertation, Draft, December 1989, University of Maryland, College Park, Maryland.

Four cans to three cans: -2.05
Five cans to four cans: -2.14

The Utility had only aggregate subscription levels on which to base its estimates -- that is, it knew what percentage of customers were subscribed to which service levels before and after rate changes. This made the estimation difficult, because no data were available on the actual subscription changes made by any particular customers.

Utility staff had to make simplifying assumptions in order to make any use of the admittedly poor data available. The first was that customers generally switched down only one service level. The staff also assumed that no customers switched "up" in service levels. This allowed the utility to "back out" the percentage of customers that must have switched down in service levels. Knowing the changes in rate levels for each can level then allowed a calculation of an elasticity for each subscription level:

$$\frac{\text{the percentage change in customers shifting down from that subscription level}}{\text{the percentage change in the rate for that subscription level}}$$

Because the Utility introduced an entirely new service level in 1989 -- the "mini-can", judgment was used to determine the percentage of customers that would move from the one can subscription level to that service level. The Utility estimated that a total of 34% of customers would select mini-can service after considering both the effects of tonnage and rates incentives.

Comparing the results of the subscription levels that actually occurred in 1989 with those forecast showed that the elasticities produced too many customers on the one can, too few on the one can service level, and too few on the two-and-above service levels. This implies that the elasticities for all service levels were too low, and that the Utility's assumption about the number of customers that would subscribe to the mini-can was somewhat optimistic. Three factors affected the quality of the elasticity estimates: 1) the problem of poor data, 2) the introduction of an entirely new service level, and 3) the fact that a number of new waste reduction and recycling programs were introduced along with the rate change.

More appropriate levels of elasticities for the 1989/1990 rate change, which included the introduction of new programs, would have been double the levels listed above. Further, the assumption that customers moved only one subscription level was found to be inaccurate. Approximately 45% of customers stayed at the same subscription level; 42% reduced their subscription by one service level; 7% reduced two service levels; and 3% reduced three service levels. The number of service levels that customers reduced was higher at higher starting subscription levels, with many at very high levels reducing to one or two cans. This may be partly because the new rates caused these customers to finally notice the level of their bills. In addition, the new and expanded programs provided customers with more options for their waste.[29]

[29] More empirical information on customer choice and elasticities is included in Skumatz, "Empirical Analyses of Solid Waste Customer Subscriptions and Choice" (available from the author, Synergic Resources Corporation, Seattle, Washington), presented to the Western Economics Association, 1990.