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MEASURING SUCCESS IN DIVERSION… "BEST PRACTICES": ALTERNATIVE MEASUREMENT OF RECYCLING, DIVERSION, AND WASTE PREVENTION

-- FINAL REPORT --

PREPARED AS PART OF ALAMEDA COUNTY SOURCE REDUCTION AND RECYCLING BOARD / 2006 MEASURE D "FIVE YEAR AUDIT" PROGRAM ASSESSMENT

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1. INTRODUCTION

This report has been prepared to assist StopWaste.Org staff in evaluating alternative ways to measure diversion and monitor program success. Any jurisdiction with limited budgets or accountability requirements knows how essential it is to assess the performance of programs. However, evaluating programs can serve many purposes, and some evaluation approaches serve different objectives or goals better than others. Regardless, basics on a few techniques may be useful to program managers.

Evaluations can provide information to measure progress toward goals, justify budgets, examine program tradeoffs and optimize program portfolios, identify when programs are no longer needed, refine programs, and myriad other uses. In this report, we examine approaches for tracking progress, program attribution, evaluation methods, program logic, performance indicator development, and augmented indicators related to environmental and other "indirect" effects from diversion programs.

This paper develops a set of recommendations and suggestions related to "best practices" in diversion program measurement and evaluation. The results are based on more than 30 years of SERA experience evaluating resource programs (recycling and energy), interviews with communities across the US, and review of the literature in the field of evaluation methods.

The goal is not to provide complicated methods or recommendations; instead, this report exposes the reader to alternatives that may be helpful approaches to pursue, or ways to solve apparent measurement problems, depending on the evaluation or measurement objective. Although a number of concepts and terms are introduced, the point is to provide planning and evaluation suggestions that:

- inform program design, management, and decision-making and
- make program efforts and other interventions more effective.

2. EVALUATING TO TRACK PROGRESS: TRADITIONAL APPROACHES

Most communities and states around the country use one of two main methods for measuring progress in diversion:

- Landfill diversion – measuring the tonnage disposed at any and all landfills receiving waste generated in the city against a "base" year. Variations on this approach are used in California and other states, as well as many communities and joint authorities.

- Program diversion / recovery basis – measuring the tonnage diverted by each program, expressed as a percent compared to the year's generation or total diverted and disposed tons. This approach has been addressed by EPA and is a standard in many communities.

The basic advantages of each approach are shown in Table 2.1 below. The advantages of one are generally the opposite of the disadvantages of the other, so redundancy is avoided.

Table 2.1. Summary of Advantages of Traditional Measurement Methods[1]

Pros for Landfill Diversion Tracking Approach	Pros for Program Diversion Tracking Approach
• Limited number of sources for data (sometimes few and straightforward; sometimes hard to separate data for communities if routes cross community lines) • One overall measure – no "double counting" of tons • Facilitates comparison with other communities using similar definitions • Accounts for source reduction/ waste prevention, not just "diversion" programs	• Provides method to attribute tons to specific programs and initiatives and inform program-level benefit cost analyses and program refinements • Data from clear sources, although requires data from many sources • Traditional measurement approach

One other tracking method that has been used in many communities is a per-capita approach.

- Per Capita and other "Normalized" methods – Tons[2] are divided by the population or employment in the jurisdiction. This is usually applied to disposal totals and sometimes program totals, with the hope that the tons per capita disposed would decrease (or increase more slowly) than they might otherwise without programs, and that recycling per capita would increase. The approach has the advantage of "normalizing" data in a simple / clear manner, facilitating comparisons.

2.1 Case Studies: Measurement Examples from California, Oregon, and EPA

We conducted a detailed review of secondary literature as well as interviews with staff at a number of states, communities, and agencies[3] to provide feedback on current practices and strengths / weaknesses / recommendations from various locations. This information is summarized in the sections below.

[1] Some of this section was used and expanded in an assignment for the City of Fort Collins, 2006.
[2] Measured using either the landfill diversion or program diversion methods
[3] In addition to the States and agencies listed, SERA interviewed "typical" and outstanding communities in California, Colorado, Washington, and across the nation.

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2.1.1 California's Diversion Rate Approach

Background and Helpful Tools: Solid waste management planning and monitoring have been required in California since 1989. The process began when the State required each jurisdiction to conduct a waste characterization study, calculate an initial diversion rate, and prepare a Source Reduction and Recycling Element (SRRE) that described how the jurisdiction would reach the State's targets of 25% diversion by 1995 and 50% diversion by year 2000.[4] Once a jurisdiction's SRRE was approved, it was required to submit annual reports to the California Integrated Waste Management Board (CIWMB). Thus, some jurisdictions have been submitting annual reports for close to 15 years. During this time, the reporting process has evolved some, but continues to be based on the same general diversion rate formula.

The CIWMB specifies the contents of the annual reports, but not their format. The CIWMB does, however, provide a model report that jurisdictions can use and submit electronically. To help with reporting, the CIWMB provides extensive information on its website, under the section called "Local Government Central" (www.ciwmb.ca.gov/LGCentral). The site includes, for example, the model report, a diversion rate measurement calculator, waste characterization data, per capita disposal rates, and disposal rates by business types (e.g., tons disposed per restaurant employee per year). The CIWMB cautions that some of the information is provided for planning purposes only and should not be used as measurement tools.

Methodology: California calculates diversion in tons as follows:

DIVERSION = GENERATION - DISPOSAL

The method for calculating diversion for the base year is somewhat different than for subsequent years.[5]

Disposal: Initially and subsequently, disposal is based on actual facility records, and includes both landfilled and exported material. The robustness of this figure depends on the availability, reliability, and completeness of facility records.

Generation: For the base year, generation is the most elusive figure. It is usually a combination of reported and modeled data. After the base year, the generation rate is adjusted annually using changes in population, employment, and inflation-adjusted taxable sales growth. This rate can also be adjusted for unusual events, such as major disasters, and for imports.

Diversion: Diversion is then the difference between generation and disposal. Once generation and disposal tons are determined, diversion can also be expressed as a percentage. For instance, the State diversion rate for 2004 was 100% - 52% = 48%.

Recently, the CIWMB has looked more and more closely at the demographic and economic factors used to adjust generation rates in order to identify relevant trends. For example, in recent years construction

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[4] This is a simplified description of the process!

[5] Note, there is an option for jurisdictions to calculate diversion by tallying records and estimates for various source reduction and recycling activities. However, when the reporting requirements were first adopted, few jurisdictions had extensive recycling programs in place, and thus chose to use the method described above. However, according to the County, most Alameda County had instituted programs and tried to quantify adjusted / updated base years through waste sorts and other methods.

employment in the state has grown far faster than average employment. This additional information has provided useful guidance for program planning.

Over time, California's method has proven more accurate for large jurisdictions than for small. Rural and small jurisdictions are more sensitive to single changes in the waste stream. For example, several large self-haul loads to the landfill will be felt more in the numbers for a small jurisdiction than for a large one.

Note that most Alameda County member agencies did try to quantify the base year through waste sorts and other means, but that in many cases, a particular difficulty arises in quantifying non-municipally controlled programs (e.g., those happening outside of any regulatory environment).

2.1.2 EPA'S Method For Determining Recycling Rates

Background and Helpful Tools: The U.S. EPA developed and released a recycling measurement tool in 1997 that "ensures fair comparison of recycling rates among jurisdictions, produces useful information for planning and decision-making, provides accurate, up-to-date numbers for market development, and allows for easy data collection from the private sector."[6] The tool is available on the EPA's website at www.epa.gov/recycle.measure/index.htm. It includes a guidance document; worksheets; sample survey forms for recycling collectors, processors, disposal facilities, and end users; planning checklists; and volume-to-weight conversion factors. Pennsylvania, Washington, the Northeast Recycling Council (www.nerc.org), and others have all used the EPA's measurement tool.

The recycling rate is based on tons recycled as follows:

RECYCLING RATE (%) = MSW RECYCLED x 100 / TOTAL MSW GENERATED

This method relies on distributing survey forms to solicit data about the quantities of materials collected, processed, disposed, and recycled.

The method also relies on "traditional" definitions of municipal solid waste (MSW) and recycling. The definition of MSW does not include, for example, construction and demolition (C&D) debris and sewage sludge. The definition of recycling includes, for example, off-site composting, but not backyard composting. Data for these materials can be collected and analyzed separately using the same basic methodology.

2.1.3 Oregon's Annual Recovery Rate

The State of Oregon's Department of Environmental Quality (DEQ) calculates a statewide "Annual Recovery Rate" each year. The DEQ's process is a unique approach, quite elaborate, and much more extensive than necessary for a single jurisdiction.

The DEQ has been calculating the State's Annual Recovery Rate since the early 1990's, and now uses a sophisticated software program to run the calculations. The data are based on mandatory reports submitted by haulers, some large generators, and recyclers (scrap metal dealers are exempted). The reports include how much was recycled and to whom it was sold. DEQ tracks the materials to their endpoints, and then balances what is bought and sold. This is a very labor-intensive effort and requires

[6] Quoted from EPA literature.

substantial legwork by the DEQ staff. The resulting information is reported back to each "wasteshed" (counties or other jurisdictional entities) in the state.

2.2 Recommendations

SERA has worked with many communities to develop or improve measurement of diversion. We generally suggest that one method is not enough to meet all the tracking needs of the community.[7] We usually recommend two basics, with individualized variations:

- Per-capita landfill diversion, with the suggestion that both per-capita (or per household) and per-employee figures are calculated. Examining / tracking both can help explain and provide comparisons for the typical community (with the residential / commercial split in the Alameda County member agencies approximately one-third / two thirds).
- Program diversion approach, because it provides critical information on which programs are responsible for diverting high levels of material, or critical materials, and supports analyses of program- or portfolio-based effectiveness.

No one measure is perfect. Using both provides a fairly well-rounded analysis of diversion performance – either over time (within a community) or for comparisons between communities.

Complications very often arise in measuring non-residential tonnages. Disposal tonnages for large generators may be available (if facilities are public). Implementing an ordinance that requires quarterly tonnage reporting as a license requirement can also help in data collection, even though it may not be entirely accurate or complete. The information may need to be augmented by surveys with self-haulers, businesses, facilities, or others to get a more complete view of trash and/or recycling tonnage from the sector. With limited resources, proxy estimates may be generated using on-line data on generation or disposal by business sector, "multiplied up" to represent the number, size, and distribution of businesses by sector in each community.

Approaches for Augmented Measurement to Match Policy Goals

Note that we recommend augmenting these "direct" measures of progress with indicators of auxiliary impacts, including economic multipliers, greenhouse gas effects, and other market and other progress attributable to the actions of programs. This is addressed in Chapter 5 of this report. In addition, we recommend considering "qualitative" and quasi-quantitative effects from programs (see Chapter 4). Measurement-related recommendations are summarized in Chapter 6.

[7] In particular, SERA's research has shown that one measure does not easily substitute for the other. For example, in one report, SERA demonstrated that actual computed landfill diversion metrics and program-related diversion do not follow a predictable relationship. See Skumatz, Lisa A., Ph.D., "Achieving 50% in California: Analysis of Recycling, Diversion, and Cost-Effectiveness", 1999, Prepared for California Chapters of SWANA, Skumatz Economic Research Associates, Inc., Superior, CO.

3. ATTRIBUTING NET EFFECTS TO PROGRAM INITIATIVES

Two refinements to program measurement are very important:

- **Net tons**: Programs should only be "credited" with the tons they actually cause to happen – that is, the effects above and beyond what would have happened without the presence of the program. That means looking for "net" new tons. The total tons managed by a program may not represent the tons that are truly "attributable" to that program's influence. The purpose is to identify those "tons" that would not have been diverted had it not been for the program – i.e., looking for "tons" that are above and beyond what would have happened had the program not been in place.[8]

- **Tons that "don't happen"**: Second, an additional complexity arises in association with measurement of waste prevention and education programs. While the program diversion / recovery approach can indicate the tonnages attributable to many programs, it cannot easily measure tons that "don't' happen (waste prevention) or assign tons to programs that don't assemble or collect the material directly (a la education).

Suggestions for how to measure both of these effects have been presented in articles by the author in various articles and papers (Skumatz 2000, Skumatz 2001, among others) and abbreviated summaries are provided in this chapter.[9] Surveys and statistical techniques[10] have been used in developing these estimates, particularly for the waste prevention work.

3.1 Pre-Post Approach

One method of identifying "net" tons attributable to the program is to conduct a pre/post analysis. Planning ahead and tracking "baseline" data – the "before" case – is an important method of developing estimates of program impacts. However, note that the changes in tons diverted by a program before vs. after a particular change cannot necessarily be attributed solely to the program. For instance, consider a program that started in December, and ended in February. The difference in tonnage diverted may be due to high volumes at the holidays and low in the short month of February; there may be effects due to weather differences, and myriad other causes.[11] The example in Table 3.1 illustrates the effect on a hypothetical diversion program.

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8 Note that this also means the "net tons" should be measured at a consistent (relevant) point, and net of any differences in contamination or other factors that may affect net tons at that point. Based on the definition of a community's goal, the relevant point may be collected materials delivered to processing, may be net after processing, or may be some indicator of sales to market. For California's landfill diversion metric, the most appropriate point perhaps should be net of processing and contamination, as the contamination would presumably be landfilled. No consistent generalizations may be made about contamination between single stream and dual stream plants, as there are low and high contamination plants of each type – related to age, equipment steps, and management commitment. While some have argued that single stream plants lead to greater contamination of paper, many of the single stream plants have better performing (newer) container lines, leading to less contamination of these streams. The comparison of contamination is appropriately compared plant by plant. (On single stream and contamination issue, see Skumatz, "Single stream recycling: Assessing the tradeoffs", *Resource Recycling*, August 2004.)

9 Additional work on measuring waste prevention was also included in extensive work for Alameda StopWaste and in work for Portland Metro.

10 Including cross section, time series, and pre/post techniques with and without control groups.

11 Assuming even that the program change was the only change made in the system – an unlikely occurrence.

The first line shows the "gross" ton difference from a pre-post comparison counting only the participant routes. The second line incorporates an improved comparison. Assume data were collected on "control group" routes that are "similar" to the program participants. The "net" difference in weekly pounds per household is presented in the third line (5.2 tons). This is a corrected estimate of the change in tons attributable to the program and is the most appropriate number to use in derivations of program effect, cost-effectiveness, and other program assessment calculations.

Table 3.1. Example of Pre-Post Evaluation, With and Without Control Group

Group	Average pre-program pounds per week disposed	Average post-program pounds per week disposed	Calculated reduction from program
Participant	43.9	38.2	5.7
Control	44.1	43.6	0.5
Net attributable diversion due to program			5.2

3.2 Net-To-Gross (NTG)

In assessing the tons attributable to the program, there are two relevant concepts SERA brings over from our 30 years of evaluating energy programs:[12] free ridership[13], and spillover[14].

- Free ridership: Free riders are those participants (or tons) that are delivered to the program, but that would have been recycled even without the presence of the program to which they were delivered. The easiest example of this is a new curbside recycling program that draws tons away from a drop-off program already in place. The higher the percent of curbside tons that were transferred from the dropoff program, the higher the free ridership, and the lower the "net" tons attributable to the new curbside program.[15] Free ridership decreases the tons "attributable" to a program. An example of the difference in a program's "attributable" tons after considering free ridership is provided in Figure 3.1.

[12] These principles and associated analysis methods are illustrated in more detail in Skumatz 2005 and Skumatz 2006, among others.
[13] Also known as "net effects".
[14] Also known as "market effects".
[15] Program types that would tend to have high free ridership would be those that, for instance, expend dollars to incentivize or educate people about behaviors that are already fairly common (e.g. if duplex set copiers were common, but a big advertising campaign was undertaken, high free ridership might result). Lower free ridership would occur if more "cutting edge" behaviors were encouraged. Note, however, if there was greater "bang" from duplex copying, a high free ridership figure might still result in more net tons for the duplex program than the cutting edge program.

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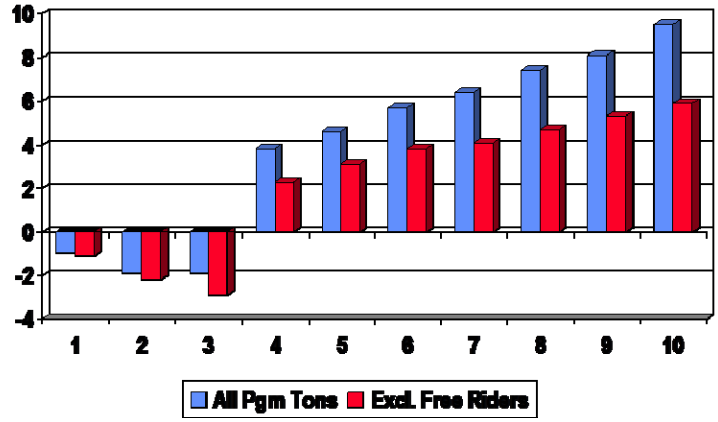
- Excluding an analysis of free ridership means over-counting the impact of the program (or the tons attributable to that program). Any analysis of cost-effectiveness that excludes a free ridership[16] or "net" assessment would under-estimate the cost-effectiveness of the drop off program, and over-estimate the cost-effectiveness of the curbside program.[17]

Figure 3.1: "Net" Present Value of Program Counting All Tons vs. "Attributable" Tons ($3 million vs. $0.7 million)
(x axis is year; y axis is net program costs in millions of dollars net per year)



- Spillover:[18] Some programs also cause more diversion than is actually counted as part of a program's records. For example, getting people to start recycling in a curbside program may increase sensitivity to the environment, and may cause some households to adopt waste prevention behaviors, begin composting, or increase recycling outside the curbside program. This would tend to increase the tons "attributable" to that program's influence.[19] These spillover effects may also be achieved through designing programs to encourage more actions by participants, or provide information or motivation to "the market" including actors that are not participants in the program. Education programs are also noted for achieving spillover.

  - Excluding an analysis of spillover may mean under-counting the impact of the program (or the tons attributable to that program).

The combination of these two effects (computed as (1-free ridership)*(1+spillover) is called the "net to gross" ratio (NTG). This ratio is an easy way of expressing the translation from gross or measured tons to those tons (or other effects) that can be attributed to the program. Net to gross ratios and their component parts provide valuable information for program assessment and refinement. If a program has a very high free ridership value, it is not providing much additional tonnage for the effort. It may be time to revise or phase out the program. Its value may be increased if the program adds new materials that are not collected through other programs; that would reduce the cannibalism of tons pulled from other programs.

High spillover values are often associated with outreach and training programs, among others. Programs with high spillover values will see higher cost effectiveness than if the program did not

16 Free ridership estimates are usually derived using surveys of people that participated, using carefully worded questions asking what they would have done without the new program. Alternatively, some pre-post measurements can be used to estimate free ridership. Other approaches are also available, including control groups.
17 Note that in computing cost-effectiveness for the program, only the "net" tons should be counted, but all the costs attributable should be counted.
18 Also called "free drivers" in older energy literature.
19 For those interested, there are three types of spillover, but that is more detail than space allows. Spillover is also usually assessed using specially worded survey and analysis techniques.

encourage spillover – or encourage behaviors "beyond the scope" of the direct program. Designing programs to achieve spillover may help multiply the effects from a program that is more narrowly targeted.[20]

3.3 Measuring Waste Prevention: Examples for Measuring Tons that "Don't Happen"

Waste prevention measurement does not really lend itself to "cookbook" approaches. Instead, we present two case studies in this section – representing two alternative methods that SERA used to measure source reduction / waste prevention from Pay As You Throw (PAYT) trash rate incentives, a measure of tons that "don't happen".[21] To demonstrate the practical potential of measuring waste prevention, SERA selected PAYT as the demonstration because:

1) The program was in place in thousands of communities nationwide, making it common enough to be familiar, and to potentially be associated with significant waste prevention tonnage;
2) PAYT, unlike more limited recycling programs, is expected to lead to waste prevention;
3) Previous work by SERA had already measured the direct recycling and yard waste impacts from PAYT, leaving only the important and potentially large (but "hard to measure") source reduction aspects to be measured to understand the combined impacts of PAYT;
4) We believed the program would lend itself to measurement using methods adapted from our energy work; and
5) Finally, the authors had unique data on the adoption of these programs that would help in the estimation work.

3.3.1 Time Series Method

The project used nationwide data from EPA/Franklin Associates on municipal solid waste (MSW) disposal and incineration, recycling, and yard waste tonnage covering the period from 1960-1998. The approach was to develop estimates of generation with and without PAYT, and then decompose this "gross impact" by deleting the influences of packaging changes, and the impacts of PAYT/VR on recycling and yard waste, so we could estimate a "net" impact of PAYT on SR.

We used multivariate regression techniques to develop a forecasting model for generation as a function of key demographic and economic variables (population, households, income measures, price indices, recycling prices, and SERA's data on the growth in participation in PAYT/VR over the period). This model provided a prediction for generation per capita. The generation forecast was compared with and without the PAYT/VR factor to provide a "gross" impact. Then, using a "packaging index" that SERA developed from work by The Garbage Project in Tucson, AZ, the gross estimate was refined to remove the impacts of packaging changes on SR over the period so that PAYT impacts on SR would not be overestimated. As a third step, we estimated similar forecasting models for recycling and yard waste models and again estimated the influence of the PAYT factor on recycling and yard waste/composting. The resulting figure

[20] In the energy field, "market transformation" programs were specifically designed to achieve these types of effects. For example, some programs were designed to train architects and builders in "whole building" design and building techniques. With advertising, customers start to demand this type of performance, so non-participating builders would need to learn the methods in order to compete, and the market would "transform" and move forward due to the program.

[21] These abbreviated descriptions are pulled from SERA Fact Sheets / Research Study Summaries prepared November 2000. The full report, covering the estimation methods is Skumatz, Lisa A., Ph.D. "Measuring Source Reduction: Pay as you Throw / Variable Rates as an Example", Skumatz Economic Research Associates, Superior, CO May. The methods were presented in concept in Skumatz 1993b, Skumatz 1996, and Skumatz 1999 in the references.

represents the estimate of the "net" impact of PAYT/VR on source reduction. The results of the estimation work are summarized in Table 3.2.

Table 3.2: Estimated Impacts of PAYT/VR on Source Reduction Using Time Series Method

(Source: Skumatz, Lisa A., "Measuring Source Reduction: Pay as you Throw / Variable Rates as an Example", Skumatz Economic Research Associates, Inc., Seattle, WA, May, 2000)

Source of Impact	Estimated Percentage Impact (1999)
Gross impact of PAYT on SR	19.7%
Impacts after removing packaging index impacts	17.3%
Removing PAYT impacts on recycling	-6.9%
Removing PAYT impacts on yard waste	-4.6%
Net impact of PAYT/VR on SR	5.8%

3.3.2 Cross Section Approach

Communities rarely have accurate and thorough data from before and after implementation of their programs, so we used cross section techniques to estimate and attribute the impacts to programs. Comparing information from many towns at one point in time avoids having to find "matched" towns, increases the sample sizes and variation for the estimation work, and decreases the variability from other time-related factors (like changes in packaging, changes in demographics, etc.) increasing the overall reliability of the estimates. The project used a database of programs, demographics, costs, and tonnage information from a sample of 1,000 communities nationwide assembled by Skumatz Economic Research Associates (SERA).

We fitted multivariate linear regression models to explain generation (defined as the total of recycling, yard waste, and disposal tonnages) in the communities. The statistical models allowed us to separate out the effects from income, population, and other demographic influences and most importantly, whether or not the community had a PAYT program. These models showed that average generation rates for communities with PAYT/VR were 16.1% lower than those without the PAYT/VR program.

Estimates of the impacts of VR/PAYT programs on recycling and yard waste diversion were then developed so we could subtract their influence and separately identify the remaining SR impacts of the program. These were estimated in Skumatz 1996 and Skumatz 1999, which had applied similar techniques to explaining the differences in recycling and yard waste diversion between communities as a function of a wide variety of demographic factors and numerous specific program design elements (collection frequency, materials collected, etc.) and the presence of PAYT/VR programs. Significant increases in recycling and yard waste diversion could be attributed to the PAYT/VR programs.[22] The results of the estimation work are summarized in Table 3.3.

[22] As it happens (and reassuringly), these recycling and yard waste results were also very similar to those developed in the time series approach described above

Table 3.3: Estimated Impacts of PAYT/VR on Source Reduction Using Cross Section Method
(Source: Skumatz, Lisa A., "Measuring Source Reduction: Pay as you Throw / Variable Rates as an Example", Skumatz Economic Research Associates, Inc., Seattle, WA, May, 2000 and Skumatz, "Nationwide Diversion Rate Study – Quantitative Effects of Program Choices on Recycling and Green Waste Diversion: Beyond Case Studies", SERA, 1996)

Source of Impact	Estimated Percentage Impact
Total Effect of PAYT/VR	16%
Minus recycling effect	5-6%[23]
Minus yard waste effect yields	4-5%[24]
Estimated Source Reduction effects attributable to variable rates/PAYT program	5-7%

In the PAYT report, SERA also used the pre/post method mentioned above to estimate waste prevention from PAYT. Follow-on work used the results from these three methods – cross section, time series, and pre-post – to compute total estimates of waste prevention tons from the PAYT program nationwide, as well as percentages that communities could use as benchmarks for program planning purposes. In addition, the work estimated revised benefit-cost ratios for PAYT programs, and other indicators.

[23] Skumatz, Lisa A., Ph.D., "Nationwide Diversion Rate Study – Quantitative Effects of Program Choices on Recycling and Green Waste Diversion: Beyond Case Studies", Skumatz Economic Research Associates, Inc. (SERA), funded by SERA, APC, SRI, Reason Foundation, EPA Region 3 and Region 6, October 1996
[24] *ibid.*

4. THREE TYPES OF EVALUATION: PROCESS, PROGRESS, AND IMPACT

For decades, three key types of analyses have served as the basis for the evaluation of programs in the energy field. Each provides different information and takes different data and analytical methods. In the energy sector, Public Utilities Commissions (PUCs) are typically charged with constant evaluation, updates, and tracking of program progress. In the majority of energy efficiency programs, PUC stakeholders demand constant updates to determine the effectiveness of these programs, even going so far as to set aside an average of 5-15% of the program's overall cost to evaluation. These same evaluation methods have strong relevance to solid waste programs.[25] Both have the need to deliver quality service, be efficient and cost-effective, justify budgets, and demonstrate progress toward measurable goals to justify expenditure of public funds. The evaluations provide valuable information to help improve the design and delivery of programs. Each of the three evaluation approaches is valuable, providing feedback on different aspects of the program.[26] ***Most importantly, in all these efforts, the evaluation and the indicators should be geared to reflect program goals or success.***[27] Summary descriptions of the three methods follow.

4.1 Process Evaluation

This type of evaluation examines the administration and implementation of the program. Process evaluations usually include a review of program documentation, conversations and interviews with program staff, both inside and out of the actual program, and customer interviews (including both participants and non-participants). Process evaluations have the advantage of dealing with a number of issues related to the program's internal processes and determining what in the program's design, delivery and administration are proving to be successful or not. Process evaluations collect data from a number of sources, including, but not limited to program plans, budget documents, progress reports and a wide swatch of interviews. This data is used to create a quasi-quantitative report of the program. Unlike the other two evaluation methods, process evaluations often tell a "story" of the program, with an analysis of the steps of the program, activities and deadlines set up by the program, bottlenecks and problems, and strengths and weaknesses. Process evaluation reports display the goals and the progress the program has made toward achieving those goals, design suitability of the program, and recommended changes to improve to program.

A key aspect of the process evaluation lies in the interviews. Detailed interviews are conducted with representatives from each of the types of staff involved with the program. In a curbside recycling program this could include the recycling coordinator, outreach staff, other city staff, haulers, and staff at the MRF. Staff interviews will show what the staff perceives as the goals of the program and whether or not they have been achieved, the strengths and weaknesses of the program's operation, the inner workings of the program administration, perceptions of participants, and useful context information. Interviews should also be conducted with the customers. In the example of a curbside recycling program, these participant customer interviews would be conducted with residents that are using the new curbside program. Just as

[25] SERA has been applying these techniques to solid waste programs for more than a decade, and have given workshops in multiple jurisdictions.

[26] For example, author Skumatz instituted a version of these evaluation methods in Seattle.

[27] However, indirect indicators can be useful. For instance, in measuring the success of a hazardous waste program designed to decrease use and purchase of hazardous cleaning supplies, we used indicators of incidence of child poisonings.

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important as these participant interviews are the non-participant interviews. By interviewing residents in the same or similar area who are not using the curbside program (a "control group"), and comparing the two groups, the process evaluation allows the evaluator to determine barriers to recycling, reasons for and against participation, needs in education, program satisfaction, and other important program design factors.

4.2 Performance/Progress Indicators

Progress indicators reflect measurable benchmark goals or objectives to gauge the effectiveness of the program. The range of progress indicators varies, depending on the program. By linking the progress indicators that are being researched to the program's goals, effective indicators can be constructed that monitor program progress. If well constructed, these can provide leading indicators allowing timely remediation of program problems or allowing the community to capitalize on upcoming successes.

To provide a well-rounded assessment of the overall status and progress of a program, we usually ensure there are indicators representing the following five key categories, and that a quarterly tracking system is set up in a spreadsheet program, with a regular reporting pipeline.

- Activities: Activity indicators reflect products and activities, often tasks and benchmarks for the program. For instance, activity indicators may be number of calls made, number of participants, number of brochures distributed, number of businesses receiving audits, number of waste reduction recommendations made, number of bins distributed, and other similar indicators – presumably representing some of the most important program deliverables on the critical path to achieving program impacts. These are usually the easiest to gather.
- Effects (or impacts): For most programs, tons would be a valuable indicator of program effects.[28] In others it might be the number of waste prevention recommendations implemented, the percent of households aware of the program, or other indicators of program effects.
- Effectiveness: Effectiveness indicators are usually constructed as ratios of relevant effect and activity indicators, for example, tons per participant, implemented recommendations per suggestion or per business visited, or similar indicators, tailored to the program.
- Costs: Tracking program expenditures relative to the program's budget is a normal part of program tracking, and should be incorporated into the model.
- Cost-effectiveness: Cost-effectiveness is constructed as a ratio of costs divided by effects, for instance dollars per ton collected, dollars per waste prevention participant or per recommendation implemented, and similar effects.

There are many examples of indicators, but each program will be best described using indicators tailored for that program's objectives. For example, recycling programs often seek to change consumer behavior and/or increase awareness. Broad recycling program goals could be to increase collection opportunities, increase awareness of recycling locations and recyclables, increase diversion, and decrease recyclables disposed of in the trash. Once the general goals have been determined, they can next be expanded to form a more refined set of measurable goals that can be used as progress indicators. Examples of some of these refined goals are: add 5 recycling dropoff sites within the county, increase recycling hot-line calls by 10%/year, achieve 75% awareness of recycling program among citizens, and increase diversion rate to 25%. It is important that evaluator limit themselves to only a select number of meaningful indicators. It is easy to get bogged down by the numbers and in many scenarios, a few select indicators will better serve the evaluator then a wide array of overwhelming indicators. When choosing the indicators, be sure

[28] Tons collected via a curbside program may be an example. Of course, although "net" tons (as described in an earlier section) would be preferable, the on-going nature of these "indicators" may mean that for performance evaluations, the gross tons are used in-between periodic impact evaluations.

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that they are not all measured in tons, but instead include a mix of tonnage, scores, and levels of satisfaction or awareness.

Each category of indicator brings some element of the program's path to success – toward that goal – forward. Programs aren't implemented (well) if the appropriate activities aren't undertaken to initiate forward motion. Measures of impacts are key elements to assure effects (and the right types of effects) are realized from the intervention. Effectiveness measures are an important type of progress indicator because they indicate program efficiencies in delivery of effects. Examples of these ratio-based measures might be: cost of garbage per ton collected, per capita cost of curbside recycling, and operating cost for solid waste management per ton. Budgets are routinely tracked and, like the activity indicators, reflect progress in program delivery. Finally, the ratio between effects and budget reflect cost-effectiveness, an important element of program decision-making.

The data for progress indicators is collected through program records and budgets, field data, and constructed ratios of this collected data. Some types of progress indicators may rely on data collected from surveys, including indicators related to program awareness, satisfaction, effectiveness, and other key indicators. However, it is important to recall that a number standing alone is not a measurement. Program indicators without some baseline number for comparison are not effective metrics for program effectiveness – whether that is a comparison from a previous period or against other programs in the portfolio, or comparisons against similar programs in other locations. Finally, it is also important to recall that more data or more indicators are not equivalent to more information. A few well-selected indicators that reflect (directly or indirectly) program progress will be more useful to decision-makers in determining program performance than comprehensive but overwhelming metrics.

4.3 Impact Evaluation

Measuring the impact of a program is often the most complex evaluation, because it means identifying the "net" tons attributable to the program – a concept that was introduced earlier in this report. The difficulty arises when the evaluator attempts to measure the program's impacts beyond what would have happened without the program and identify only the impacts that can be attributed to the program's effort. To properly do this, "free ridership" and spill-over must be addressed as previously mentioned, and the evaluation needs to control for impacts that are not due to the program. As with the other evaluation options, a control (or comparison group) or baseline measurement is integral.

Difficulties in measurement arise from the fact that many of the impacts are qualitative and by definition are "hard-to-measure". For recycling, many of these benefits go far beyond the benefits of saving space in the landfill. An example of a relatively easy to measure impact of a recycling program is the reduced greenhouse gas emissions from trucks hauling trash. A "hard-to-measure" impact could be the personal value that participants derive by "doing good for the environment".[29] A negative impact could be the perceived cost to residents of the reduced aesthetics of the neighborhood, caused by the oversized brown recycling toters on neighborhood curbs. An implication of these "hard-to-measure" impacts on evaluation is that many programs go unmeasured, and if measured without these benefits, the impacts can be under or overvalued. By transferring established metrics and techniques from the field of energy conservation, program impacts can be better ascertained. Sources of data for impact evaluation include on-going measurement and observation of tonnage, costs, and generation, and advanced survey collection. Data collection for both participants and control groups is needed.

[29] A discussion of measuring these types of effects is included later in this report.

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4.4 Choosing the Appropriate Evaluation Method

Each evaluation provides valuable feedback on aspects of the program's performance and effects. Which type of evaluation to undertake depends on the (importance of the) decision the evaluation is helping to inform, and the time, funds, and data available for the assessment. The first consideration is the cost of evaluation relative to the cost/importance of the program which is being evaluated, and the second is the cost of the evaluation relative to the importance/potential cost of the decisions being made. Another factor to consider is the appropriateness of the evaluation to the program being studied. Some programs require a strict quantitative analysis while for others, a qualitative evaluation is better suited. Some of the remaining issues to be considered when choosing an evaluation method are data needs / availability, time required vs. available, and the capabilities of the available staff.[30] In any case, the authors recognize the 80/20 "rule of thumb"[31] and recommends spending sufficient and appropriate – but not excessive – funds on evaluation efforts, and recommends using a balanced approach to provide valuable quantitative and qualitative information that can help guide each program's (or portfolio's) refinement.

The basic elements of each evaluation method are summarized in Table 4.1 below.

Table 4.1. Summary of Evaluation Types – Process, Indicator, and Impact (© SERA)

Evaluation	Timing / Cost	Type	Topics	Data Collection
Process Evaluation	Periodic, moderate cost	Qualitative	Program design, administration, and delivery toward refinement	Staff interviews, review of documents
Progress Indicator	Ongoing, inexpensive	Quantitative and semi-qualitative	Ongoing activities and efficiencies toward identifying bottlenecks, inefficiencies	Ongoing tracking of activities and results
Impact Evaluation	Periodic, costly	Quantitative, statistical, analytical	Effect of program "beyond what would have naturally occurred" toward cost-effectiveness	Pre-post surveys, monitoring, tonnage, costs, effects to be compared to baseline and control groups

[30] For major energy programs, process evaluations are often conducted every year or two, impact evaluations every two years or so, and progress indicators are an on-going activity.
[31] Recognizing that getting exact data or more perfect results can be very disproportionately expensive. It is variously interpreted as getting 80% of the value from the first 20% of the effort; or other permutations.

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5. AUGMENTED INDICATORS – ANALYZING ENVIRONMENTAL AND BROADER EFFECTS FROM PROGRAMS

The direct benefits of waste prevention and diversion programs are generally reductions in disposed tonnage (and potentially the valuation of those bill savings). However, in many cases, programs have goals beyond tonnage and disposal reductions – potentially related to sustainability and other indirect program effects.

5.1 Measuring Auxiliary Effects

While some of the computations of auxiliary effects are fairly direct, others can be quite difficult to measure, especially for local programs. However, there are practical measurement methods that can provide insight into many important categories of benefits.

- Using input-output modeling techniques to estimate job creation and economic multipliers from the program.[32]
- Using EPA's WARM model or other tools to estimate emission impacts from diversion, source reduction, recycling, and yard waste diversion[33]
- Using and leveraging information from existing life cycle analysis studies to provide estimates of additional effects of the programs.

Each of these methods is described in more detail below.

5.1.1. Economic Multipliers for Economic Development / Job Creation

Using input-output modeling techniques, jobs and direct and secondary economic impacts from changes associated with new programs can be predicted and valued. To estimate impacts on 1) jobs, 2) direct economic multipliers, and 3) indirect multipliers, two cases are computed and compared – the baseline and "impact" scenarios. First, a baseline model assuming the status quo is estimated. Then, another run of the model is computed, taking money away from specific sectors (e.g. landfilling, box manufacture, etc.) and adding the dollar impacts to other specific sectors (recycling, plastic bags for shipping, etc.). The net impacts in jobs, direct, and indirect economic multipliers associated with the program are computed as the difference in these outputs between the two scenarios.[34] We have found the job creation and economic development impacts to be quite high in association with a variety of recycling programs, waste audit programs, and others, and have found significant variations by type of program, "level" of the program (local, statewide, etc.), as well as area of the country.

5.1.2. Valuing Emission Impacts

The EPA's WARM model and other models can be used to translate changes in landfilled vs. recycled vs. composted and, indirectly, source reduced tons into impacts on greenhouse gases (GHG). These

[32] See, for instance, Woods and Skumatz 2004.
[33] See, for instance, Skumatz 2006a.
[34] This model has been used successfully by the author to estimate the net economic impacts of a low income weatherization (energy conservation) program in California, and the model was relatively user friendly.

GHG tonnages can then be "valued" using regulatory, trading, or other prices from the extensive secondary literature on the value of reductions in GHG and included as additional program savings. The user inputs the tons going to landfill, recycling, and yard waste composting without the new program's influence, and then substitutes estimated input data on tons for landfilling, recycling, and yard waste with the new program or intervention in place. The model provides net estimates of carbon, CO2, and Btu (energy) equivalents from the program's effects. Generally, in association with diversion programs we have analyzed, we find that there are strong GHG emission reductions. Using techniques like this, one city, Fort Collins, Colorado, found that nearly 40% of the City's progress toward its sustainability and GHG goals could be attributed to the waste management initiatives undertaken. Dollar values for these green house gas (GHG) and other emissions[35] are then multiplied times the tons of emissions to get the total value of avoided emissions from the program. Sources for these emission values may include the trading values, adopted regulatory values, or other values to assign dollars to the tonnage reductions in GHG.[36] The end result of the computations is the dollar value of GHG benefits from the program, and based on work we have conducted since 1999 on this topic, these values reach many millions, and in the case of one nationwide program we have evaluated, the value was tens of billions of dollars.[37]

5.1.3 Carbon Trading and Related Equivalents

The opportunity also exists to think more broadly about the values in which progress can be indicated. Some communities are recognizing the potential for local and regional carbon trading markets, and the value that diversion may represent in those markets. Communities that undertake diversion programs and policies can quantify those credits and estimate the dollar value of those credits to industry or other groups. From work SERA and others have conducted in this area in Colorado, California, and elsewhere, considerable potential has been seen. For example computing the cost for progress in carbon equivalents from different program types has telling results for program planning. Note that these findings can be translated to other "equivalents", including noting the value in terms of cars removed from the road, and other indicators. The values can also be used to examine an adjusted 'breakeven" value for programs vs. landfilling or disposal.

5.1.4. Applying Existing / Future Life Cycle Analysis Results

Finally, life cycle analysis (LCA) is a comprehensive method of measuring the wide range of positive and negative tradeoffs due to a change in practices. However, while LCA is comprehensive, it is also relatively expensive and complicated to conduct. There is a growing literature on existing LCA work and communities may be able to find results from LCA studies on similar programs that can be adapted and applied to provide policy guidance. Life cycle analysis examines the tonnage, cost, environmental, and other impacts of a behavior, program, or change over its entire life span – "cradle to grave", so to speak. After languishing in the 1990s, the technique is being applied again to waste management issues. This is partly spurred by EPA interest in the GHG impacts of waste management alternatives, and partly because ISO and EPA are establishing new standards / approaches, and other agencies are beginning to post databases useful for conducting life cycle analysis on web sites, etc.

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[35] Note some gases are not computed by WARM, and values are not readily available for some of the GHG estimated. Note that the WARM model is currently somewhat controversial, as its factors are under dispute or discussion (and are potentially being modified). Others note that the model does not accurately represent the time over which the emissions occur.

[36] For our client work on this topic starting in 1994, we have assembled dozens of different sets of dollar valuations associated with GHG effects.

[37] Skumatz and Freeman, 2006. "Pay As You Throw (PAYT) in the US: 2006 Update and Analyses", Prepared for USEPA and Skumatz Economic Research Associates, Inc., on USEPA website (www.epa.gov/payt), December.

This technique has been applied to a wide variety of waste management programs, including disposable diapers, bottle bills, and paper vs. plastic in shipping, and EPA has several studies on pollution prevention and source reduction topics. These studies are very useful – especially with the broader environmental / stewardship focus being adopted by many communities. They support recognition of not only the direct tonnage impacts of a program, but also the value in, for example, trees, GHG, fuel, water, and myriad other inputs and consequences. From a practical standpoint, it is unlikely most communities will be able to conduct its own LCA studies. Instead, where LCA studies conducted by other agencies are available on topics relevant to aspects of the agency's programs, the results should be adopted and/or adapted to the agency's decision-making or valuation processes.

5.1.5 Indirect Omitted Program Effects (OPEs)

SERA has conducted several dozen projects pioneering methods to estimate – and monetize -- "hard to measure" (HTM) indirect effects from recycling, energy, and water conservation programs. These have dubbed "omitted program effects" (OPEs). [38] These are the bundle of positive and negative effects that are often excluded when assessing program impacts – most narrowly, we include any program effects that are not tonnage-related.[39] SERA developed a system of categorizing these benefits into three groups based on the beneficiary[40]:

- **Agency effects**: These effects vary based on the program and the agency offering the program (could be state, hauler, city, etc.). These effects may include progress toward (non-tonnage) agency goals, improved service for customers, bill payment improvements and many other improvements in communication and progress toward goals.
- **Societal effects**: Examples include environmental effects and greenhouse gas reductions, job creation and economic multiplier effects, extended landfill lifetime, reduced toxicity in landfills, water / energy infrastructure savings, etc.
- **Participant effects**: Examples include changes in productivity, changes in illnesses, truck or equipment lifetime, equipment maintenance, worker satisfaction, worker environment, water / energy / other non-garbage bill savings, equipment lifetimes, liability / insurance and other auxiliary benefits that accrue from changing volumes/tonnages and practices.

Measuring societal and agency effects can be fairly directly computed, using secondary data, program data, and similar methods (e.g. water, insurance, maintenance, etc.).[41] However, a wide array of the participant effects can be especially complex to assess – at least monetarily (worker satisfaction, productivity, etc.). Although considerably more complex, these estimates can be developed using defensible methods, using specialized survey and measurement methods.[42] SERA believes information on these auxiliary benefits should be incorporated into program evaluations because of their value[43] for:

- **Enhanced benefit cost analysis for the program**. This is especially important when important goals for the program are not tonnage-related or are hard to measure. This can be used to refine the program's design and help identify the best set of measures / strategies to be incorporated.

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38 And published scores of conference articles. See references for a sampling of some of this work. The term used in the energy field for this work is "non-energy benefits"; also see www.nonenergybenefits.org for more information.

39 Some of the effects we have mentioned above (environmental / emission, economic, and other effects).

40 Note that similar impacts can appear under multiple categories, because the valuation method and beneficiary perspective differs.

41 SERA has developed a model for estimating the wide range of effects – SERA's "Sustainability Valuation©" model.

42 SERA pioneered specialized survey and computational methods (Called OPE Survey - OPES) to measure and monetize these effects. We developed consistent, tested, and defensible methods for energy conservation programs which we adapted successfully to recycling and waste prevention programs. OPES methods include specialized contingent valuation, ranking, and other survey approaches to compute the valuations.

43 In energy, we found that participants valued these benefits highly – they were often worth half as much or more of the value of the energy bill savings delivered by the program. See Skumatz 2006 and others.

- **Program marketing and targeting**. The results provide information identifying those households or businesses with highest benefits, and the results can also be used to craft outreach messages to focus on aspects of the program most valuable to the potential program participants. The example we usually use is to point out that Procter and Gamble doesn't sell Tide™ laundry detergent with the slogan to buy it because it is their highest profit margin item – even though that may well be their real desire.[44] They conduct market research that indicates the highest value features of their product and advertise the product based on those *purchaser* values. Solid waste agencies have usually already "captured" the green or environmental segment of possible purchasers. The kind of research and evaluation we describe here – SERA's OPE research method – helps move beyond continued marketing on "green" effects, and identifies the features most highly valued by purchasers, providing the most effective message for that next group of potential recyclers / participants.
- **Understanding barriers to program participation**. SERA notes that negative OPEs are essentially program or measure / strategy barriers. The monetizing work provides a direct measure of the most important barriers, and the value or cost of the information, education, warranty, or other intervention that the solid waste agency may need to introduce to help "get past" the barrier. This can be invaluable in refining program design and moving the program forward in the market.
- **Understanding program decision-making and waste behaviors**: The omitted effects represent the host of factors that enter into a potential participant's decisions about undertaking behaviors, beginning recycling, or other decisions. Households (and businesses) make tradeoffs about a range of factors – much as they don't buy energy conservation devices merely to save money, but to have greater comfort, etc., they don't undertake recycling solely to reduce the amount of trash in the landfill.[45] These OPEs help us understand the tradeoffs and important factors associated with undertaking behavioral changes.

Table 5.1. Omitted Program Effects: Example for Commercial Waste Prevention Program
(Source: Skumatz Economic Research Associates)

Possible Auxiliary Impact[46]	From Example Commercial Waste Prevention Activity	Possible Measurement Method
Participant Effects		
Water bill savings	Process change	Direct computations; estimates from sample measurements or manufacturer specifications tailored for installation; also specialized OPES survey / measurement methods
Electricity bill savings	Process change	Direct computations; estimates from sample measurements / metering or manufacturer specifications tailored for installation; also specialized OPES survey / measurement methods
Labor savings	Process change, operations change, change in materials or shipping	Office records, adapted manufacturer specifications; also specialized OPES survey / measurement methods
Productivity improvement	Process change, operations change, change in materials or shipping	Office records, adapted manufacturer records; also specialized OPES survey / measurement methods
Better work environment, fewer complaints from workers about building, process, etc.	Process change, operations change, change in materials or shipping	Office records, adapted manufacturer records; also specialized OPES survey / measurement methods
Fewer liability claims	Changes in process or O&M	Office records; also specialized OPES survey / measurement methods

[44] From Skumatz 2006 and many other SERA publications on this topic.
[45] In economic parlance, they are purchasing a "bundle" of features.
[46] Note that these could be ***negative*** impacts also – instead of savings, the WP change could lead to extra costs in energy bills, etc.

Possible Auxiliary Impact[46]	From Example Commercial Waste Prevention Activity	Possible Measurement Method
Savings in purchase of paper	Dual sided copying as default setting	Direct computations; estimates from sample measurements ; also specialized OPES survey / measurement methods
Savings in purchase of boxes, shipping materials	Shipping changes, procurement practice changes, operations changes	Office records, direct computations; estimates from sample measurements ; also specialized OPES survey / measurement methods
Savings in purchase of other supplies	Shipping changes, procurement practice changes, operations changes	Office records, direct computations; estimates from sample measurements ; also specialized OPES survey / measurement methods
Savings in transportation	Shipping changes, procurement practice changes, operations changes	Office records, direct computations; estimates from sample measurements ; also specialized OPES survey / measurement methods
Equipment maintenance, lifetimes	Shipping changes, operations changes	Office records, direct computations; estimates from sample measurements ; also specialized OPES survey / measurement methods
Value of "green" label	Shipping changes, procurement practice changes, operations changes	Specialized OPES survey / measurement methods
Lower use of toxics, lower hazard and cost of disposal	Process changes, procurement changes	Office records, direct computations; estimates from sample measurements; computations from manufacturer specifications adapted to installation / compared to previous equipment; also specialized OPES survey / measurement methods
Societal Effects		
Extension in LF life, capacity	Variety of WP program actions	Valuation of tonnage estimates; program records; also specialized OPES survey / measurement methods
Lower use of toxics, pollution prevention benefits	Process changes, procurement changes	Office records, direct computations; estimates from sample measurements; computations from manufacturer specifications adapted to installation / compared to previous equipment
Job creation from reduction of use of certain input materials, transfer of activities from disposal to reduction, recycling, compost	Process change, operations change, change in materials or shipping	Input-output model computations
Economic multiplier from reduction of use of certain input materials, transfer of activities from disposal to reduction, recycling, compost	Process change, operations change, change in materials or shipping	Input-output model computations
Emissions reduction from reduction of use of certain input materials, transfer of activities from disposal to reduction, recycling, compost; carbon equivalent computations	Process change, operations change, change in materials or shipping	Modeled computations; secondary information, WARM model, valuation figures from literature or tailored estimates
Agency Effects		
Diverting tons from disposal, extension of LF life / capacity	Variety of WP program actions	Program records; impact evaluation
Meeting 20% or other diversion goal	Variety of WP program actions	Program records; impact evaluation
Program effects, cost-effectiveness	Variety of WP program actions	Program, diversion, and accounting records; evaluation efforts

5.2 Developing Other Indicators of Program Progress

There are a range of other tools and indicators of program progress and the value provided by diversion programs.

5.2.1 Set Out Surveys – Tracking Participation and Much More

Even simple set out surveys, recording the participation of households or businesses in recycling, can provide very valuable – and very cost-effective – "progress" indicators related to program use as well as the effectiveness of related outreach efforts. For example, recording whether recycling is set out, whether the recycling containers contain materials that were most recently added to the program, whether the materials were set out properly, and whether illegal materials are being set out can provide data that are easily collected in a clipboard-based "drive-by" survey.[47] Yet even with this simple survey, a time series can be collected that shows increases or decreases in participation, and lets the city know whether information on materials and preparation is well understood. And on the residential side, enhancing the set out survey by simply recording how full the recycling containers are allows computation in growth of volume of recyclables per household while still conducting the work as a "drive-by" or "windshield" survey. Going a step further and weighing the garbage can and recycling containers can provide a very defensible estimate of recycling diversion.[48]

These surveys are not expensive, and can provide accurate information as long as more than about 170 households are inspected; a better survey would involve about 360 households.[49] To keep costs down, recall that the "random sample" of households could include 60 homes with the 5 homes following the address. This helps the inspectors "beat the trucks", and the geographic clusters reduce travel time and labor needed. An additional enhancement might include selecting 30-50 homes of waste and recycling, and sorting them at a transfer station (perhaps pulling the materials from the starting homes in the sample). Given that the key information is tracking and potential, the categories can be kept reasonable. While sorting into 20 categories is painful and expensive, sorting only into categories that will be important to the tracking or planning work is relatively inexpensive. For example, it might be sufficient to only sort to represent "currently recyclable", yard waste, and a set of materials a program might be considering adding. Sorting into these basic categories provides information on the percent of material that is still "capturable", and what potential might be realized by adding additional materials.

Commercial "drive-by" surveys are also fairly easy to conduct, and provide information on progress in non-residential recycling. Again, drawing a sample of random blocks in the community (or random businesses and the next several businesses) provides a method to draw a reliable and convenient sample (with a size matched to labor available to conduct the work). Noting the presence of recycling containers can provide data indicating the growth in recycling participation by businesses. Recording volumes is not as easy in the commercial sector, as collection frequencies vary. A waste characterization study is very useful, although somewhat more complicated to organize.

While some communities conduct very elaborate studies, we find these data collection efforts are not outside the realm of most communities, because the 80/20 rule really comes into play -- the vast majority of important data can be collected very inexpensively, and the additional information provided by expensive studies may not always be central to guiding real world program-related decisions. We find

[47] Set out surveys are also an extremely valuable tool in a Pay As You Throw (PAYT) feasibility study.

[48] The authors have conducted this research for 6 years running in one community on a very cost-effective budget, and the results have guided program changes and education/ outreach materials.

[49] These sample sizes provide +/-5% at the 90% and at the 95% confidence levels, respectively for a wide range of community sizes.

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getting out and seeing what people are really doing is infinitely valuable. Conducting these studies periodically generates important feedback that cannot necessarily be gathered via other methods.

These simple studies provide opportunities to track changes in participation, volumes, inclusion of specific materials, and in the effectiveness of specific education messages.

5.2.2 Waste Sorts / Composition Surveys

Conducting a simple (above) or more complex waste characterization study provides an opportunity to track whether a program has been effective at reducing either the percent or the tons (or tons per capita, etc.) of specific materials included in the program or outreach messages. Progress in a waste ban may be reflected by a significant decrease in that material in the waste stream, measured pre- and post- ban. Progress in a recycling program may be reflected in a decrease in the pounds per household of the program-eligible materials in the residential waste stream over time.

A waste sort of a random (or stratified random) sample of commercial businesses, although more complicated to undertake, may be one of the most valuable ways of identifying what is currently happening in the commercial sector, and what materials or sectors might be targets for commercial program initiatives. Combined with a survey (see following sections), a community can obtain a very useful summary of progress and needs in non-residential recycling. Several states conduct periodic statewide waste sorts (Oregon is an excellent example), and either coordinating with this sort, or for large cities, paying for an oversampling in their area, may be very beneficial, cost-effective, and provide comparability state-wide in progress and potential.

5.2.3 Value Remaining in Landfill

One other indicator of success in diversion is to compute the value of recyclable materials still being disposed or remaining in the landfill. This is best accomplished using a simple or more complex waste characterization study (above) and valuing the materials at current market prices. This indicator provides an easy method of communicating with policy makers and elected officials about the potential remaining in the ground, and may help grease the wheels for more program funding. Computing the value in total, as well as per capita, can provide another simple-to-express indicator of progress, and help reflect the changing values of recycling over time as well.

5.2.4 Tracking Progress in Attitudes, Program Understanding, Barriers

A mail, telephone, or web survey, administered to a sample of households (and potentially, a sample of businesses) can yield valuable information and provide data for tracking indicators on key topics, including:

- Awareness of program, recall of outreach
- Accuracy of knowledge about the program and its operation / expectations
- Current recycling and waste prevention behaviors
- Strengths and weaknesses of current programs
- “Next” program or material needs, and
- Many other topics.

Residential surveys are fairly straightforward; however, a great deal of information can be asked in commercial surveys as well. We have used this method to gather information on current disposal and recycling volumes and practices, costs, importance, barriers, feedback on intervention suggestions, business issues, decision-making, and a host of other data. It can be used as a supplement to a waste composition survey, or can provide approximate materials and volumes that may substitute for more

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expensive data collection – a substitute that may be fully sufficient for program planning and decision-making purposes.[50]

Even a short survey conducted every other year (or pre- and post- a big campaign or initiative) can provide information for tracking progress in program awareness and use, behaviors, and a great deal of other information useful in evaluating the current program mix and in planning refinements to the current program and any next steps in a broader program planning context. However, to be thorough, it would be especially valuable to conduct a survey several years later; persistence of changes in behavior or program participation is an important element of the program's effect, and may help identify elements to make the outreach more memorable.[51]

Changes in attitudes are also important indicators of market progress. Given the type of attitudes that are critical to getting "green" initiatives adopted, tracking progress in "self-efficacy", or the adherence to underlying feelings of self-empowerment and influence on the larger world relate closely to the proportion of the population willing to adopt green behaviors and programs. Examples of these studies are provided in the reference section.[52] SERA found that households with higher "self-efficacy" attitudes (e.g. what I do makes a difference, even if others don't) recycled 11% more than those with low self-efficacy scores. Using outreach to help reduce feelings of powerlessness may help increase the adoption of diversion programs / behaviors by the "next group" of households (and potentially businesses) beyond those already participating.

5.3 Summary of Auxiliary Benefits and Benefit Cost Issues and the Role of Integrated Waste Management

These computation approaches can provide dollar estimates of the wide range of auxiliary impacts associated with waste diversion and prevention programs and interventions, including benefits to participants and to society at large. These estimates can be incorporated into the benefit/cost computations associated with the overall program, and used to provide an enhanced evaluation of the program's impacts. Of course, these estimates of auxiliary benefits should be "net" benefits – including both positive and negative impacts due to the program. Generally we have found that including these benefits increases the benefit-cost ratio for the program.

Revised Benefit/Cost ratio = (tonnage-related savings + value of sum of net auxiliary benefits) / (program costs)[53]

The benefit-cost ratios for individual programs and strategies may be strong, even without estimates of many of these benefits. For example, many waste prevention programs are often undertaken via just a change in behavior by the participant, involving no investment in new plants or equipment – minimizing the cost.[54] Using these results, the evaluator can also construct benefit cost ratios for different

[50] Including work for Alameda County, Snohomish County, and other jurisdictions.

[51] The authors point out that very few education programs, for instance, have checked this element. See Skumatz 2000b, and Skumatz, Mulholland, and Barata 2007.

[52] This includes: Coghlan and Skumatz, ECEEE 2007, and Skumatz, ACEEE 2004, among others.

[53] Note that one other approach is to compute different benefit-cost ratios that vary based on the "perspective". For instance, the energy field evaluates programs based on the total resource cost test, the ratepayer test, and other metrics, each of which have specific sets of benefits and costs included and excluded.

[54] For energy programs, we usually recommend that the basic benefit-cost ratio be presented without auxiliary benefits, and then incorporating percentages of the auxiliary effect to compute revised, more complete, benefit-cost ratios for the program. Program staff can determine which of the range of possible auxiliary benefits are most suitable to be included in these estimates.

perspectives – the city or agency (incorporating relevant auxiliary benefits), the societal perspective, and the participant perspective. Each provides valuable information about the program, and the participant perspective in particular can help explain the decision to participate or not in programs, and provide insights useful for program targeting and marketing.

There are some that will be skeptical of including auxiliary benefits – especially those benefit categories that are hard to measure. However, ignoring an important benefit (or a cost) that is difficult to measure introduces a "zero" into an equation where we know that a value is needed. Developing at least order-of-magnitude estimates is important information to support program decision-making.[55] However, for early program planning efforts, time should be focused on fairly direct benefits, those that are easily and unambiguously computed, and those that reflect benefits to the participants. These will be most useful in moving the program forward into the market, and will be least subject to skepticism by those reviewing the program.

[55] See Skumatz ACEEE 2002, and others in the reference list.

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6. SUMMARY AND RECOMMENDATIONS

Programs are important; however, evaluating the impacts of the program is also important and should be an important part of assessing whether the program is an appropriate expenditure of public funds. Evaluation does not have to be difficult (or expensive), but it is much easier (and less costly) if it is planned for and embedded into the program's initial plan. Evaluations are important in providing information to measure progress toward goals, justify budgets, examine program tradeoffs and optimize program portfolios, identify when programs are no longer needed, refine programs, and myriad other uses.

Based on almost three decades of evaluation experience in energy and solid waste, extensive interviews with solid waste agencies, and review of the literature, we have summarized methods of assessing and measuring impacts from diversion programs, and provide recommendations on a menu of useful and practical indicators and approaches. Although the recommendations may seem overwhelming, in fact, they are designed to streamline a community's efforts in planning and evaluation to focus on those with greatest value and efficiency. Table 6.1 and Table 6.2 below itemize the planning and measurement recommendations from this report.

Table 6.1. Recommendations for Planning and Measuring Success in Solid Waste Programs

Topic	Recommended Tracking Elements	Notes
Measuring Tonnage Effects	• Per capita disposal • Per employee disposal[56] • Percent diverted by specific programs	Use multiple measures for tracking tons and diversion (per-capita and per-employee landfill diversion, and program diversion) and incorporate attribution and impact evaluation techniques to identify attributable "net" tons.
Progress Indicators	• Activity • Effect (awareness, participation, etc. depending on program) • Effectiveness (effect/activity) • Cost • Cost-effectiveness (cost/effect)	Incorporate a priority array of indicators that are linked back to program goals and the program's interventions that are designed to address barriers (per the program theory and logic. *In these efforts, the evaluation and the indicators should be geared to reflect program goals or success.*
Auxiliary Indicators to include (when related to goals)	• Dollar value of agency, societal, and participant impacts [57] • Economic, job development, tax effects • Emission / GHG reduction values • Values from phases of life cycle analysis • Values remaining in landfill • Carbon values and equivalents (cars removed from road, etc.)	These may require conduct of surveys, set out survey, waste composition work, and other analyses. However, each of these efforts may be able to assess the impact of more than one program, and if designed efficiently, the costs can be relatively low. However, the monetization of agency, societal, and participant impacts may require special analyses.[58]
Research Steps – Evaluation	• Indicators • Surveys and measurement • Evaluation, conclusions, recommendations	The program goals directly relate to the development of program indicators that will be the focal points of the evaluation – and thus of the data collection work for the evaluation. Surveys and other measurement work are planned and undertaken, and the evaluation analysis and recommendations feed back into the program's design. The results may indicate changes in the program or suggest programs that have reached the time for exit from the marketplace.

[56] A per employee metric introduces the complexity of attempting to estimate the employees that work (not live) in each jurisdiction. While not common, some cities with significant influxes of employees have estimated these figures for employment tax purposes (Washington DC) and planning departments or entities associated with mass transit may have information on these figures.
[57] There are a wide variety of these impacts – agency, societal, and participant – depending on program. Examples for a commercial waste prevention program were presented in Table 5.1 in this report.
[58] The authors have a model that automatically computes many of these values – SERA's "Sustainability Valuation©" model and specialized OPEs survey methods.

Table 6.2: Measurement Recommendations

Purpose	Recommendation
To establish the baseline and plan programs	Conduct a limited waste generation study (WGS) to understand the local waste stream. Use a combination of the WGS data and simple modeling to develop plan. (Can use factors provided in state or EPA calculators.)
To monitor and evaluate individual programs	Develop a monitoring program prior to implementing the recycling program. This will ensure that you have collected the right kind of base information. Monitoring and evaluation for individual programs are usually custom-tailored for a specific program or set of programs. What is measured, how it is measured, and when it is measured varies widely. "What" may include, for example, weight, participation rates, customer satisfaction, cost, contamination rates, capture rates. They may be quantified at the source (e.g. residential routes) or central location (e.g. composting facility). "How" may be, for example, by observation, equipment, survey, anecdotally, or formal study. "When" may be determined by whether the program is a pilot or for the long-term, and whether there are significant seasonal or other variations (e.g. tourism or university related).
To monitor and evaluate the overall "set" of programs	Tabulate individual programs OR tally disposal and subtract from adjusted base year generation rate, depending on availability of information. Conduct periodic WGS for feedback and planning purposes. WGS may be more or less extensive depending on need for updated information. Some recommend conducting a WGS every five years; others recommend every ten years.
To measure broader impacts of programs and initiatives	Analysis of societal, participant, and agency effects from programs using program data, secondary data, direct/indirect computations, estimates adapted from manufacturer specifications, and OPEs specialized survey and measurement methods.

6.1 Comments on Program Progress Measurement

In this section, we summarize a number of comments from SERA interviews regarding measurement of program and community diversion progress.

Baseline Information

- Setting a solid base year is essential for future comparisons and reporting.
- Before planning programs initially, look closely at the local waste stream and waste flows. Fifteen categories of waste types may be sufficient (versus 98 for some states / jurisdictions!).
- Determine from the outset whether to include university-related materials and wastes in the waste generation study and plan.
- Most problems with base year disposal rates stem from poor data regarding imported and exported wastes.
- Most under-reporting for diversion is related to source reduction activities.

Materials of interest for baseline and planning purposes

- Tires (From the public health and nuisance points of view.)
- Vehicles (Whether or not to include auto bodies has been a long-standing controversy.)

- Bulky wastes (Track these consistently. In Oregon, whether a refrigerator counts or not depends on whether it is delivered to a drop-off facility or scrap dealer.)
- Electronic wastes (Of interest due to hazardous components, and as growing component of the waste stream.)
- C&D debris
- Materials used for alternative daily cover at landfills
- Sewage solids
- Materials targeted in national, state, or local programs
- Materials with strong local market development potential

Special Populations

- Jurisdictions in California with large colleges have run into problems when calculating rates based on population (e.g. Davis). Students may not be attributed to their college locations during the 10-year census. Thus the population data may under-report actual population.

New Sector

- Several jurisdictions are considering collecting and reporting data specific to large events, such as sports events, conventions, and festivals.

How Much is Enough?

- While some monitoring and evaluation is necessary, it is better to focus more on implementing programs than on detailed monitoring and evaluation. These efforts can be time-consuming and costly. Data collection and analysis always takes longer than you think they will. (Heard from almost every interviewee.)
- There is ongoing discussion in the recycling community about whether to move away from mandated numerical goals (e.g. 50% by 2010) toward mandated programs and/or best management practices. There are advantages and disadvantages to both. Measurement approaches would vary somewhat, depending on how the ultimate goal is stated.

Diversion Rate Based on Disposal

- A diversion rate based on disposal provides information about general trends, but not about diversion per se, and certainly not about particular diversion programs. Annual diversion rates provide only aggregated information; they do not distinguish between programs that are performing well and ones that are not.

Qualitative Monitoring

- All interviewees recommended collecting qualitative as well as quantitative information when monitoring programs.

6.2 Recommendations on Program Progress Measurement

Key findings and recommendations include the following:

- **Multiple Measurement Approaches:** Communities should consider monitoring progress in more than one way. It is important to include a strong overall indicator of progress, but should also monitor program-by-program impacts to provide information necessary to watch for indications of program progress or stalling and to provide feedback to help improve programs.

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- **Optimal Level of Effort:** "Reasonable" efforts should be expended to try to monitor progress – extraordinary efforts that take significant time away from actual delivery of programs is not well-spent. Precise data in this field is difficult (and time-consuming) to obtain – and in fact, it is not possible to collect truly accurate information on several types of diversion (e.g. commercial recycling, backyard composting, etc.). The underlying principle should be that the **level of effort in evaluation is sufficient to provide data that can reflect progress, avoid "wrong" decisions about programs**, and assist in identifying need for program changes or new programs; however, it does not have to be much more accurate than that. The effort should not take away from development and implementation of needed programs.

- **Collect Qualitative and Quantitative Data:** Information on how programs are working is not just gathered numerically – it is important to conduct interviews and gather qualitative information as well in order to assess the progress of programs and the possible need for changes in existing programs or adding new programs.

- **Consider Mandatory Programs to "require" progress:** Many communities are reducing efforts for detailed measurements and to assure continued progress in diversion, they are just adding new "mandatory" requirements and programs as part of the portfolio to make sure diversion increases over time. This is an element that may be useful to consider; however, evaluation is also an important part to assure program funds are being well-spent and that programs are continuing to deliver valuable and worthwhile services, commensurate with their funding or needs.

7. BEST PRACTICES SUMMARY

Table 7.1 presents a summarized version of "best practices" in measurement and evaluation for solid waste management programs.

Table 7.1. Suggested Best Practices in Evaluation and Measurement

SERA's "Best Practices" in Evaluation and Measurement

- Tracking tonnage progress: Landfill diversion, program tracking, per capita approaches were discussed. Given the strengths and weaknesses of each, there is no one best method. The suggestion was made that both a per-capita and per-employee landfill disposal number should be tracked, to provide a strong overall indicator of the impacts being made by the host of recycling, waste prevention, and education programs and policies implemented. However, program-by-program tonnages and diversion are also essential computations in order to identify progress attributable to specific programs, to assess efficiency, cost-effectiveness, and to indicate if and when it might be time to exit a particular program or market.

- Program attribution: Methods of attributing the tonnage impacts specifically due to programs – in a "net" sense, were discussed. Pre-post, net-to-gross, free ridership, and other concepts were introduced, and their relevance to recycling and diversion programs was discussed. In particular, it is important to assure that the programs are only credited with the "new" or "net" tonnage they divert, and that if they cannibalize other programs (as a curbside program might do to an existing dropoff program) that only the new tons are counted in conducting a cost-benefit analysis or in discussing increases in diversion due to the program.

- Process, Progress Indicator, and Impact Evaluation Methods: Three evaluation methods have traditionally been applied to energy programs, and each is also applicable to solid waste programs. Process evaluations provide feedback on how well the program is working in the field; progress indicators provide on-going information on impacts and bottlenecks in time for real-time remediation; and impact evaluations provide periodic quantitative data on the program's attributable tonnage effects. A well-designed set of on-going progress indicators related to activities, effects, effectiveness, costs, and cost-effectiveness will provide coverage for principal programs. Each evaluation method addresses different aspects of the program, and each provides valuable program feedback.

- Augmented / Auxiliary Indicators: Although their primary target is diversion of tonnage from disposal, programs deliver an array of valuable impacts that affect three beneficiary groups: the agency delivering the program (e.g., extension of landfill lifetime, meeting goals, tax effects), society (e.g., pollution prevention, economic development / job creation, emission reductions); and participants (e.g. water / electric bill savings, productivity improvements, reduced input purchases, value of "green" label), and many others. These effects can be measured and valued and included in benefit cost results by "perspective" and overall. Auxiliary benefits can also include: economic multiplier effects (which vary by program type and region); value of emission and greenhouse gas effects, value of effects along the goods' lifecycle, value of materials left in the landfill, value of carbon in the trading market, and other "monetizable" effects. Other indicators that reflect program progress can be measured through cost-effective set out surveys (participation, education effectiveness, recycling rates, and other indicators), waste sorts (reflecting decreases in disposal of program-targeted materials), and surveys (for tracking attitudes, understanding, behaviors, etc.).

Other tips and recommendations related to "Best Practices" for measurement and evaluation work.

- Remember that more data is not necessarily more information. Pick a limited number of meaningful indicators and don't overwhelm either the reader or the data collection work. Set up the indicators in a spreadsheet program and automate the generation of graphs and tables reflecting the results.
- A number is not very useful unless it is compared to another number – whether that is the same indicator in a previous time period, or comparisons to programs elsewhere.
- Include a mix of programs – even if they are not all the highest in terms of benefit-cost ratios. It is important to include a mix of residential and commercial programs, and incorporate education programs (which often have "iffy' benefit/cost ratios) as well as direct service programs. However, evaluation results can help select the best performing programs for the portfolio.
- Integrated waste management is the goal. Use evaluation results to identify which programs are more cost-effective than disposal. Those are clear winners. And be willing to consider broader costs than just landfill savings. Examining the full benefit-cost ratio including auxiliary benefits may better reflect the societal benefits of program options – an appropriate perspective for cities, counties, states, and other governmental levels.
- Plan, but verify! And be willing to change your program for the greatest performance and sustainability of the program portfolio.

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