DISSECTING WASTE STREAMS

Conducting a wasteshed analysis for waste-to-energy feasibility involves understanding waste composition, quantity and energy value.

Proper planning of a waste-to-energy (WTE) facility requires reliable data on solid waste characteristics and quantities generated within the service area of the facility. Such data is necessary, not only for assessing the current refuse disposal needs of the community, but also to forecast future requirements of the solid waste disposal system. The quantities of solid waste generated by the community impacts the sizing of proposed WTE facilities, emergency/ash residue landfills and other ancillary facilities, as well as identifying the most efficient location of such facilities to minimize transportation costs.

Further, the quantities of solid waste generated by the community will help assess the financial feasibility of a proposed facility since the revenues generated through the sale of energy and recovered materials are directly correlated to the amount of solid waste received by such facility. The composition of a community's waste is an important factor since it can affect the energy content of the waste received by a facility, as well as the quantities of recyclable materials and residues that may be generated. Thus, waste composition can influence the design criteria and economics of any WTE facility. Recycling programs for inert materials and metals such as glass, aluminum and ferrous are complementary to WTE systems.

CONDUCTING A WASTE COMPOSITION STUDY

SCS Engineers, Long Beach, California, recognizes that different

BY MARC J. ROGOFF, PH.D. AND STACEY DEMERS

municipal solid waste (MSW) streams have the potential to contain different types of materials in different quantities. To estimate the WTE capacity that can be supported by a community's waste stream, separate waste composition estimates can be developed for each waste stream. Waste streams normally targeted include:

- residential MSW;
- commercial MSW; and
- bulky solid waste.

The residential and commercial solid waste streams are sampled according to a plan based on tonnage receipts. A visual characterization can be conducted of the bulky waste materials that are delivered to the landfill for disposal. Bulky wastes typically are not compatible for processing through a WTE facility unless a preprocessing step is included.

Waste Sampling. Sampling typically targets larger waste streams. For example, if residential waste comprises 80 percent of the waste received at a disposal facility, then 80 percent of the waste samples should be residential. Residential waste sampling can be further targeted to specific haulers or geographic areas that generate significant quantities of waste.

During a waste characterization study, samples are gathered from targeted waste loads, usually by originating route or neighborhood. The driver is directed to discharge the vehicle's waste loads to a designated area. Usually there is a brief interview with the driver to verify the contents of the waste load and that it originated from the targeted sector.

Once the waste load is discharged, a 200-pound sample is acquired from a random location of the load. The sample is then transported to the work area where it is hand-sorted into various material categories.

Manual Sorting. ASTM procedure D 5231-92 defines the method to sample and sort waste into various material categories. Waste samples are usually placed onto a tarp or an elevated table and separated by hand into the predetermined material types. Separated materials are placed in containers to be weighed and recorded.

Large, heavy or bulky waste items, such as bags of yard waste or plastic bottles, are torn open, examined and then placed directly into the appropriate waste container for subsequent weighing. Waste is manually segregated until the entire sample is sorted or until no more than a small amount of homogeneous fine material (mixed residue) remains. The overall goal is to sort each sample directly into the material categories in order to reduce the amount of indistinguishable fines or miscellaneous categories. Each material category is then weighed using a precalibrated scale.

The number of samples is dependent on the objectives of the study. SCS generally recommends at least 25 residential samples and at least 25 commercial samples, although the number of samples may vary depending on the estimated quantity of waste delivered from residential and commercial sources.

Data Analysis. Once all samples are sorted and the information is recorded, the data is usually entered into a customized database. The composition of the various waste streams is estimated using the ratio of the weight of each material to the total sample weight. From this compilation, a recoverability analysis can be conducted. The effect of existing recycling programs can be assessed according to the relative presence of recyclable materials in the waste stream. Additionally, composting programs can be assessed by the quantities of food, yard waste and low-grade paper such as napkins and tissues.

BTU VALUE

Since the sale of energy plays an important role in the economic feasibility of a WTE project, the heating value of the waste stream is a key design factor. The heating value of solid waste is measured in British thermal units (Btus) per pound of refuse. One Btu is defined as the amount of energy required to raise the temperature of one pound of water one degree Fahrenheit. Thus, the heating value is a basic measure of the heat energy released through the incineration of solid waste.

The Btu content of MSW is well documented. Btu content is dependent on the composition of the waste stream. The *Handbook of Solid Waste Management* indicates a range of 2,500 to 8,500 Btu per pounds of waste. The range is dependent on the definition of waste and varies from 8,500 Btu per pound for trash, which is defined as: "… highly combustible waste, paper, wood, cardboard, including up to 10 percent treated papers, plastic or rubber scraps; commercial and industrial sources," to 2,500 Btu per pound for garbage, which is defined as waste materials from animal and vegetable sources, restaurants, hotels, markets, institutional, commercial and club sources.

A more accurate method to determine Btu content of MSW is to utilize the Btu content for individual waste components and apply those to the waste characterization data obtained as part of the study. The *Handbook of Solid Waste Management* provides Btu values for 15 waste components, which are presented in Exhibit 19 and includes a description of the material categories. When the handbook does not provide a specific heating value for a waste material, we typically consider information from other sources for established waste component heating values. A surrogate measure of the heating value of a waste can be estimated by considering and combining the heating value of the individual waste components and applying engineering judgment based on previous experience.

WASTE QUANTITIES

The quantities of solid waste generated by a community can be obtained from a number of data sources. The primary sources of data are records kept by landfill operators in the community over several years. These data, however, may be incomplete due to poor or variable recordkeeping from one location to another. The waste disposed of at such locations may be recorded on a volume basis rather than being weighed on a scale. Additionally, waste may also be disposed of illegally, never entering the community's waste disposal system. These problems are not uncommon throughout the United States, and esti-

Population data are useful to help compare existing records of solid waste tonnages for a community. A per capita solid waste rate can be developed, which can then be compared to generation rates for other communities with similar characteristics to determine reasonableness of such a solid waste generation rate.

Waste characterization studies call for sampling and hand sorting.

mating procedures must be utilized to develop reasonable solid waste generation rates for the community.

Population data are useful to help compare existing records of solid waste tonnages for a community. A per capita solid waste rate can be developed, which can then be compared to generation rates for other communities with similar characteristics to determine reasonableness of such a solid waste generation rate.

In some instances, it may be useful to develop per capita generation rates for different solid waste classifications (e.g., residential, commercial and industrial) to assist in this comparison and to determine the reasons, if any, for differences between the community's per capita generation rate and other similar communities. In this way, high or low rates may be easily explained due to certain specific local factors. The key point of such an analysis is to estimate a reasonable solid waste generation rate which the community can guarantee to deliver to a WTE facility, and upon which long-term waste projections can be based. In this way, the WTE facility can be prudently designed and sized to accommodate future expansion due to population growth.

Gathering Information. Several published resources are typically used to develop a list of viable target solid waste facilities, which might provide waste quantities for the WTE facility and be cross-referenced to the listing of solid waste facilities permitted by state agencies in the potential wasteshed region. Typically, this database includes a geographic information system (GIS), electronically sortable list of facilities, which includes pertinent information such as:

- facility type;
- facility address;
- owner/operator description;
- contact information;
- facilities permit number;
- daily average throughput;
- permitted and remaining capacities; and
- tipping fees.

Using these reference sources, a compilation of existing permitted landfills and transfer stations in the area is developed along with the estimated driving distance to each facility from the WTE facility.

Transportation Costs. Assuming a 24-ton load per transfer vehicle, the average base transfer is often quoted as approximately $0.13 per ton roundtrip mile. Assuming a $3.50 per gallon diesel fuel cost, the total estimated transportation cost would be approximately $0.133 per ton roundtrip mile ($2,014). This is based on recent SCS experience gained on several large long-haul transport projects around the U.S. and is a conservative approximation of transportation costs in the solid waste industry for long-haul transport.

Nonetheless, fuel prices are difficult to predict because of uncertainty in the oil markets worldwide. For example, in 2013, oil prices varied from $150 per barrel to $75 per barrel, and the reported prices for diesel fuel varied in 2013 from nearly $3.00 per gallon to just over $4.50 per gallon, with wide fluctuations up or down during the past year.

As such, the transportation cost element of the overall cost of disposing of solid waste in the United States could be highly variable and a continued significant cost element of any solid waste program. For the purposes of a Pro Forma project analysis, we suggest that assumed fuel prices should escalate at the Consumer Price Index (CPI). However, this assumption can be adjusted for sensitivity purposes.

FINAL THOUGHTS

In recent years, we have helped several WTE developers and public authorities in evaluating the feasibility of new or additional WTE and waste conversion disposal capacity. As this article illustrates, there are various tools that can be used to assess the quantities of fuel available in the prospective facility's wasteshed, its composition, and the Btu value this waste has in a traditional waste incineration or waste conversion process. All of this information provides specific details for the project developer to assess the financial feasibility of the project.

Dr. Marc Rogoff is a project director in the Tampa office of Long Beach, California-based SCS Engineers. Stacey Demers has 24 years of experience in solid waste management planning.